



STATE OF UTAH - DEPARTMENT OF ADMINISTRATIVE SERVICES

Division of Facilities Construction and Management

DFCM

STANDARD LOW BID PROJECT

March 14, 2006

CENTRAL BOILER PLANT AUTOMATION AND 15 KV POWER METERING

**SOUTHERN UTAH UNIVERSITY
CEDAR CITY, UTAH**

DFCM Project Number 05120730

Intermountain Consumer Professional Engineers
1145 E South Union Ave
Midvale, Utah 84047
(801) 255-1111

TABLE OF CONTENTS

	<u>Page Numbers</u>
Table of Contents	2
Notice to Contractors	3
Project Schedule	4
Bid Form	5
Instructions to Bidders	7
Bid Bond	11
Contractors Sublist Form	12
Fugitive Dust Plan	15
Contractor's Agreement	22
Performance Bond	27
Payment Bond	28
Change Order Form	29
Certificate of Substantial Completion	30

Current copies of the following documents are hereby made part of these contract documents by reference. These documents are available on the DFCM web site at <http://dfcm.utah.gov> or are available upon request from DFCM.

DFCM General Conditions dated May 25, 2005.

DFCM Application and Certification for Payment dated May 25, 2005.

Technical Specifications :
Drawings:

The Agreement and General Conditions dated May 25, 2005 have been updated from versions that were formally adopted and in use prior to this date. The changes made to the General Conditions are identified in a document entitled Revisions to General Conditions that is available on DFCM's web site at <http://dfcm.utah.gov>

NOTICE TO CONTRACTORS - REVISED

Sealed bids will be received by the Division of Facilities Construction and Management (DFCM) for:

CENTRAL BOILER PLANT AUTOMATION AND 15 KV POWER METERING
SOUTHERN UTAH UNIVERSITY – CEDAR CITY, UTAH
DFCM PROJECT NO: 05120730

Bids will be in accordance with the Contract Documents that will be available at 10:00 AM on Tuesday, March 14, 2006 and distributed in electronic format only on CDs from DFCM, 4110 State Office Building, SLC, Utah and on the DFCM web page at <http://dfcm.utah.gov>. Approved plan repositories may also obtain CDs at no cost. For questions regarding this project, please contact Craig Wessman, Project Manager, DFCM, at (801) 538-3246. No others are to be contacted regarding this bidding process. The construction budget for this project is \$150,000.00.

A **mandatory** pre-bid meeting will be held at 11:30 AM on Friday, March 17, 2006 at the Plant Operations Building on the Southern Utah University Campus in Cedar City, Utah. All bidders wishing to bid on this project are required to attend this meeting.

Bids will be received until the hour of 3:00 PM on Tuesday, March 28, 2006 at DFCM, 4110 State Office Building, Salt Lake City, Utah 84114. Bids will be opened and read aloud in the DFCM Conference Room, 4110 State Office Building, Salt Lake City, Utah. NOTE: Bids must be received at 4110 State Office Building by the specified time.

Bid security, in the amount of five percent (5%) of the bid, must be submitted as stated in the Instruction to Bidders.

The Division of Facilities Construction and Management reserves the right to reject any or all bids or to waive any formality or technicality in any bid in the interest of DFCM.

DIVISION OF FACILITIES CONSTRUCTION AND MANAGEMENT

Marla Workman, Contract Coordinator

4110 State Office Building, Salt Lake City, Utah 84114



STATE OF UTAH - DEPARTMENT OF ADMINISTRATIVE SERVICES
Division of Facilities Construction and Management

DFCM

PROJECT SCHEDULE

**PROJECT NAME: CENTRAL BOILER PLANT AUTOMATION & 15 KV POWER METERING
SOUTHERN UTAH UNIVERSITY – CEDAR CITY, UTAH
DFCM PROJECT # 05120730**

Event	Day	Date	Time	Place
Advertisement Placed	Sunday	February 12, 2006		Multi-Media
Bidding Documents Available	Tuesday	March 14, 2006	10:00 AM	DFCM, 4110 State Office Bldg, SLC, UT or DFCM web site *
Mandatory Pre-bid Site Meeting	Friday	March 17, 2006	11:30 AM	Plant Operations Bldg. SUU Campus, Cedar City, Utah
Last Day to Submit Questions	Monday	March 20, 2006	4:00 PM	DFCM, 4110 State Office Bldg, SLC, UT
Final Addendum Issued	Thursday	March 23, 2006	4:00 PM	DFCM, 4110 State Office Bldg, SLC, UT or DFCM web site *
Prime Contractors Turn In Bid and Bid Bond / Bid Opening in DFCM Conference Room	Tuesday	March 28, 2006	3:00 PM	DFCM, 4110 State Office Bldg, SLC, UT
Sub-contractor List Due	Wednesday	March 29, 2006	3:00 PM	DFCM, 4110 State Office Bldg, SLC, UT FAX 801-538-3677

* DFCM's web site address is <http://dfcm.utah.gov>



STATE OF UTAH - DEPARTMENT OF ADMINISTRATIVE SERVICES

Division of Facilities Construction and Management

DFCM

BID FORM

NAME OF BIDDER _____ DATE _____

To the Division of Facilities Construction and Management
4110 State Office Building
Salt Lake City, Utah 84114

The undersigned, responsive to the "Notice to Contractors" and in accordance with the "Instructions to Bidders", in compliance with your invitation for bids for the **CENTRAL BOILER PLANT AUTOMATION AND 15 KV POWER METERING – SOUTHERN UTAH UNIVERSITY – CEDAR CITY, UTAH – DFCM PROJECT NO. 05120730** and having examined the Contract Documents and the site of the proposed Work and being familiar with all of the conditions surrounding the construction of the proposed Project, including the availability of labor, hereby proposes to furnish all labor, materials and supplies as required for the Work in accordance with the Contract Documents as specified and within the time set forth and at the price stated below. This price is to cover all expenses incurred in performing the Work required under the Contract Documents of which this bid is a part:

I/We acknowledge receipt of the following Addenda: _____

For all work shown on the Drawings and described in the Specifications and Contract Documents, I/we agree to perform for the sum of:

_____ DOLLARS (\$_____) (In case of discrepancy, written amount shall govern)

I/We guarantee that the Work will be Substantially Complete within **120 calendar days** after receipt of the Notice to Proceed, should I/we be the successful bidder, and agree to pay liquidated damages in the amount of **\$175.00** per day for each day after expiration of the Contract Time as stated in Article 3 of the Contractor's Agreement.

This bid shall be good for 45 days after bid opening.

Enclosed is a 5% bid bond, as required, in the sum of _____

The undersigned Contractor's License Number for Utah is _____

Upon receipt of notice of award of this bid, the undersigned agrees to execute the contract within ten (10) days, unless a shorter time is specified in the Contract Documents, and deliver acceptable Performance and Payment bonds in the prescribed form in the amount of 100% of the Contract Sum for faithful performance of the contract.

The Bid Bond attached, in the amount not less than five percent (5%) of the above bid sum, shall become the property of the Division of Facilities Construction and Management as liquidated damages for delay and additional expense caused thereby in the event that the contract is not executed and/or acceptable 100% Performance and Payment bonds are not delivered within the time set forth.

Type of Organization:

(Corporation, Partnership, Individual, etc.)

Any request and information related to Utah Preference Laws:

Respectfully submitted,

Name of Bidder

ADDRESS:

Authorized Signature

INSTRUCTIONS TO BIDDERS

1. Drawings and Specifications, Other Contract Documents

Drawings and Specifications, as well as other available Contract Documents, may be obtained as stated in the Notice to Contractors.

Any person or firm that fails to return the complete set of Drawings and Specifications, or other contract documents, in good condition within ten (10) days after the time set for receiving bids, will forfeit the deposit. Notwithstanding this, if the Contract Documents are provided on a compact disc, the compact disc does not need to be returned.

2. Bids

Before submitting a bid, each contractor shall carefully examine the Contract Documents, shall visit the site of the Work; shall fully inform themselves as to all existing conditions and limitations; and shall include in the bid the cost of all items required by the Contract Documents. If the bidder observes that portions of the Contract Documents are at variance with applicable laws, building codes, rules, regulations or contain obvious erroneous or uncoordinated information, the bidder shall promptly notify the DFCM Representative and the necessary changes shall be accomplished by Addendum.

The bid, bearing original signatures, must be typed or handwritten in ink on the Bid Form provided in the procurement documents and submitted in a sealed envelope at the location specified by the Notice to Contractor's prior to the deadline for submission of bids. It is your responsibility to allow for the time needed to park in Capitol Hill as recent construction activity has made the parking more difficult. Identification is required to enter the building.

Bid bond security, in the amount of five percent (5%) of the bid, made payable to the Division of Facilities Construction and Management, shall accompany bid. THE BID BOND MUST BE ON THE BID BOND FORM PROVIDED IN THE PROCUREMENT DOCUMENTS IN ORDER TO BE CONSIDERED AN ACCEPTABLE BID.

If the bid bond security is submitted on a bid bond form other than DFCM's required bid bond form, and the bid security meets all other legal requirements, the bidder will be allowed to provide an acceptable bid bond by the close of business on the next business day following notification by DFCM of submission of a defective bid bond security. NOTE: A cashier's check cannot be used as a substitute for a bid bond.

3. Contract and Bond

The Contractor's Agreement will be in the form bound in the specifications. The Contract Time will be as indicated in the bid. The successful bidder, simultaneously with the execution of the Contract Agreement, will be required to furnish a performance bond and a payment bond, both bearing original

signatures, upon the forms provided in the procurement documents. The performance and payment bonds shall be for an amount equal to one hundred percent (100%) of the contract sum and secured from a company that meets the requirements specified in the requisite forms. Any bonding requirements for subcontractors will be specified in the Supplementary General Conditions.

4. Listing of Subcontractors

Listing of Subcontractors shall be as summarized in the “Instructions and Subcontractor’s List Form”, which are included as part of these Contract Documents. The Subcontractors List shall be delivered to DFCM or faxed to DFCM at (801)538-3677 within 24 hours of the bid opening. Requirements for listing additional subcontractors will be listed in the Contract Documents.

DFCM retains the right to audit or take other steps necessary to confirm compliance with requirements for the listing and changing of subcontractors. Any contractor who is found to not be in compliance with these requirements is subject to a debarment hearing and may be debarred from consideration for award of contracts for a period of up to three years.

5. Interpretation of Drawings and Specifications

If any person or entity contemplating submitting a bid is in doubt as to the meaning of any part of the drawings, specifications or other Contract Documents, such person shall submit to the DFCM Project Manager a request for an interpretation thereof. The person or entity submitting the request will be responsible for its prompt delivery. Any interpretation of the proposed documents will be made only by addenda duly issued and a copy of such addenda will be mailed or delivered to each person or entity receiving a set of documents. Neither the DFCM nor A/E will be responsible for any other explanations or interpretations of the proposed documents. A/E shall be deemed to refer to the architect or engineer hired by DFCM as the A/E or Consultant for the Project.

6. Addenda

Any Addenda issued during the time of bidding shall become part of the contract Documents made available to the bidders for the preparation of the bid, shall be covered in the bid, and shall be made a part of the Contract.

7. Award of Contract

The Contract will be awarded as soon as possible to the lowest, responsive and responsible bidder, based on the lowest combination of base bid and acceptable prioritized alternates, provided the bid is

reasonable, is in the interests of the State of Utah to accept and after applying the Utah Preference Laws in U.C.A. Title 63, Chapter 56. DFCM reserves the right to waive any technicalities or formalities in any bid or in the bidding. Alternates will be accepted on a prioritized basis with Alternate 1 being highest priority, Alternate 2 having second priority, etc.

8. DFCM Contractor Performance Rating

As a contractor completes each DFCM project, DFCM, the architect/engineer and the using agency will evaluate project performance based on the enclosed “DFCM Contractor Performance Rating” form. The ratings issued on this project will not affect this project but may affect the award on future projects.

9. Licensure

The Contractor shall comply with and require all of its subcontractors to comply with the license laws as required by the State of Utah.

10. Right to Reject Bids

DFCM reserves the right to reject any or all Bids.

11. Time is of the Essence

Time is of the essence in regard to all the requirements of the Contract Documents.

12. Withdrawal of Bids

Bids may be withdrawn on written request received from bidder prior to the time fixed for opening. Negligence on the part of the bidder in preparing the bid confers no right for the withdrawal of the bid after it has been opened.

13. Product Approvals

Where reference is made to one or more proprietary products in the Contract Documents, but restrictive descriptive materials of one or more manufacturer(s) is referred to in the Contract Documents, the products of other manufacturers will be accepted, provided they equal or exceed the standards set forth in the drawings and specifications and are compatible with the intent and purpose of the design, subject to the written approval of the A/E. Such written approval must occur prior to the deadline established for the last scheduled addenda to be issued. The A/E's written approval will be in an issued addendum. If the descriptive material is not restrictive, the products of other manufacturers specified will be accepted without prior approval provided they are compatible with the intent and purpose of the design as determined by the A/E.

14. Financial Responsibility of Contractors, Subcontractors and Sub-subcontractors

Contractors shall respond promptly to any inquiry in writing by DFCM to any concern of financial responsibility of the contractor, subcontractor or sub-subcontractor.

15. Debarment

By submitting a bid, the Contractor certifies that neither it nor its principals, including project and site managers, have been, or are under consideration for, debarment or suspension, or any action that would exclude such from participation in a construction contract by any governmental department or agency. If the Contractor cannot certify this statement, attach to the bid a detailed written explanation which must be reviewed and approved by DFCM as part of the requirements for award of the Project.

BID BOND

(Title 63, Chapter 56, U. C. A. 1953, as Amended)

KNOW ALL PERSONS BY THESE PRESENTS:

That _____ hereinafter referred to as the "Principal," and _____, a corporation organized and existing under the laws of the State of _____, with its principal office in the City of _____ and authorized to transact business in this State and U. S. Department of the Treasury Listed, (Circular 570, Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Reinsuring Companies); hereinafter referred to as the "Surety," are held and firmly bound unto the STATE OF UTAH, hereinafter referred to as the "Obligee," in the amount of \$ _____ (5% of the accompanying bid), being the sum of this Bond to which payment the Principal and Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH that whereas the Principal has submitted to Obligee the accompanying bid incorporated by reference herein, dated as shown, to enter into a contract in writing for the _____ Project.

NOW, THEREFORE, THE CONDITION OF THE ABOVE OBLIGATION IS SUCH, that if the said principal does not execute a contract and give bond to be approved by the Obligee for the faithful performance thereof within ten (10) days after being notified in writing of such contract to the principal, then the sum of the amount stated above will be forfeited to the State of Utah as liquidated damages and not as a penalty; if the said principal shall execute a contract and give bond to be approved by the Obligee for the faithful performance thereof within ten (10) days after being notified in writing of such contract to the Principal, then this obligation shall be null and void. It is expressly understood and agreed that the liability of the Surety for any and all defaults of the Principal hereunder shall be the full penal sum of this Bond. The Surety, for value received, hereby stipulates and agrees that obligations of the Surety under this Bond shall be for a term of sixty (60) days from actual date of the bid opening.

PROVIDED, HOWEVER, that this Bond is executed pursuant to provisions of Title 63, Chapter 56, Utah Code Annotated, 1953, as amended, and all liabilities on this Bond shall be determined in accordance with said provisions to same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the above bounden parties have executed this instrument under their several seals on the date indicated below, the name and corporate seal of each corporate party being hereto affixed and these presents duly signed by its undersigned representative, pursuant to authority of its governing body.

DATED this _____ day of _____, 20_____.

Principal's name and address (if other than a corporation):

By: _____

Title: _____

Principal's name and address (if a corporation):

By: _____

Title: _____
(Affix Corporate Seal)

Surety's name and address:

STATE OF _____)
COUNTY OF _____) ss.

By: _____
Attorney-in-Fact (Affix Corporate Seal)

On this ____ day of _____, 20_____, personally appeared before me _____, whose identity is personally known to me or proved to me on the basis of satisfactory evidence, and who, being by me duly sworn, did say that he/she is the Attorney-in-fact of the above-named Surety Company, and that he/she is duly authorized to execute the same and has complied in all respects with the laws of Utah in reference to becoming sole surety upon bonds, undertakings and obligations, and that he/she acknowledged to me that as Attorney-in-fact executed the same.

Subscribed and sworn to before me this _____ day of _____, 20_____.

My Commission Expires: _____

Resides at: _____

Agency: _____
Agent: _____
Address: _____
Phone: _____

NOTARY PUBLIC

Approved As To Form: May 25, 2005
By Alan S. Bachman, Asst Attorney General

**Division of Facilities Construction and****INSTRUCTIONS AND SUBCONTRACTORS LIST FORM**

The three low bidders, as well as all other bidders that desire to be considered, are required by law to submit to DFCM within 24 hours of bid opening a list of **ALL** first-tier subcontractors, including the subcontractor's name, bid amount and other information required by Building Board Rule and as stated in these Contract Documents, on the following basis:

PROJECTS UNDER \$500,000 - ALL SUBS \$20,000 OR OVER MUST BE LISTED
PROJECTS \$500,000 OR MORE - ALL SUBS \$35,000 OR OVER MUST BE LISTED

- Any additional subcontractors identified in the bid documents shall also be listed.
- The DFCM Director may not consider any bid submitted by a bidder if the bidder fails to submit a subcontractor list meeting the requirements of State law.
- List subcontractors for base bid as well as the impact on the list that the selection of any alternate may have.
- Bidder may not list more than one subcontractor to perform the same work.
- Bidder must list "Self" if performing work itself.

LICENSURE:

The subcontractor's name, the type of work, the subcontractor's bid amount, and the subcontractor's license number as issued by DOPL, if such license is required under Utah Law, shall be listed. Bidder shall certify that all subcontractors, required to be licensed, are licensed as required by State law. A subcontractor includes a trade contractor or specialty contractor and does not include suppliers who provide only materials, equipment, or supplies to a contractor or subcontractor.

BIDDER LISTING 'SELF' AS PERFORMING THE WORK:

Any bidder that is properly licensed for the particular work and intends to perform that work itself in lieu of a subcontractor that would otherwise be required to be on the subcontractor list, must insert the term 'Self' for that category on the subcontractor list form. Any listing of 'Self' on the sublist form shall also include the amount allocated for that work.

'SPECIAL EXCEPTION':

A bidder may list 'Special Exception' in place of a subcontractor when the bidder intends to obtain a subcontractor to perform the work at a later date because the bidder was unable to obtain a qualified or reasonable bid under the provisions of U.C.A. Section 63A-5-208(4). The bidder shall insert the term 'Special Exception' for that category of work, and shall provide documentation with the subcontractor list describing the bidder's efforts to obtain a bid of a qualified subcontractor at a reasonable cost and why the bidder was unable to obtain a qualified subcontractor bid. The Director must find that the bidder complied in good faith with State law requirements for any 'Special Exception' designation, in order for the bid to be considered. If awarded the contract, the Director shall supervise the bidder's efforts to obtain a qualified subcontractor bid. The amount of the awarded contract may not be adjusted to reflect the actual amount of the subcontractor's bid. Any listing of 'Special Exception' on the sublist form shall also include amount allocated for that work.

INSTRUCTIONS AND SUBCONTRACTORS LIST FORM
Page No. 2

GROUND FOR DISQUALIFICATION:

The Director may not consider any bid submitted by a bidder if the bidder fails to submit a subcontractor list meeting the requirements of State law. Director may withhold awarding the contract to a particular bidder if one or more of the proposed subcontractors are considered by the Director to be unqualified to do the Work or for such other reason in the best interest of the State of Utah. Notwithstanding any other provision in these instructions, if there is a good faith error on the sublist form, at the sole discretion of the Director, the Director may provide notice to the contractor and the contractor shall have 24 hours to submit the correction to the Director. If such correction is submitted timely, then the sublist requirements shall be considered met.

CHANGES OF SUBCONTRACTORS SPECIFICALLY IDENTIFIED ON SUBLIST FORM:

Subsequent to twenty-four hours after the bid opening, the contractor may change its listed subcontractors only after receiving written permission from the Director based on complying with all of the following criteria.

- (1) The contractor has established in writing that the change is in the best interest of the State and that the contractor establishes an appropriate reason for the change, which may include, but not is not limited to, the following reasons: the original subcontractor has failed to perform, or is not qualified or capable of performing, and/or the subcontractor has requested in writing to be released.
- (2) The circumstances related to the request for the change do not indicate any bad faith in the original listing of the subcontractors.
- (3) Any requirement set forth by the Director to ensure that the process used to select a new subcontractor does not give rise to bid shopping.
- (4) Any increase in the cost of the subject subcontractor work is borne by the contractor.
- (5) Any decrease in the cost of the subject subcontractor work shall result in a deductive change order being issued for the contract for such decreased amount.
- (6) The Director will give substantial weight to whether the subcontractor has consented in writing to being removed unless the Contractor establishes that the subcontractor is not qualified for the work.

EXAMPLE:

Example of a list where there are only four subcontractors:

TYPE OF WORK	SUBCONTRACTOR, "SELF" OR "SPECIAL EXCEPTION"	SUBCONTRACTOR BID AMOUNT	CONT. LICENSE #
ELECTRICAL	ABCD Electric Inc.	\$350,000.00	123456789000
LANDSCAPING	"Self"	300,000.00	123456789000
CONCRETE (ALTERNATE #1)	XYZ Concrete Inc	298,000.00	987654321000
MECHANICAL	"Special Exception" (attach documentation)	Fixed at: 350,000.00	(TO BE PROVIDED AFTER OBTAINING SUBCONTRACTOR)

**PURSUANT TO STATE LAW - SUBCONTRACTOR BID AMOUNTS CONTAINED IN THIS
SUBCONTRACTOR LIST SHALL NOT BE DISCLOSED UNTIL THE CONTRACT HAS BEEN AWARDED.**

**SUBCONTRACTORS LIST**

FAX TO 801-538-3677

PROJECT TITLE: _____

Caution: You must read and comply fully with instructions.

TYPE OF WORK	SUBCONTRACTOR, "SELF" OR "SPECIAL EXCEPTION"	SUBCONTRACTOR BID AMOUNT	CONT. LICENSE #

We certify that:

1. This list includes all subcontractors as required by the instructions, including those related to the base bid as well as any alternates.
2. We have listed "Self" or "Special Exception" in accordance with the instructions.
3. All subcontractors are appropriately licensed as required by State law.

FIRM: _____

DATE: _____

SIGNED BY: _____

NOTICE: FAILURE TO SUBMIT THIS FORM, PROPERLY COMPLETED AND SIGNED, AS REQUIRED IN THESE CONTRACT DOCUMENTS, SHALL BE GROUNDS FOR DFCMS REFUSAL TO ENTER INTO A WRITTEN CONTRACT WITH BIDDER. ACTION MAY BE TAKEN AGAINST BIDDERS BID BOND AS DEEMED APPROPRIATE BY DFCM. ATTACH A SECOND PAGE IF NECESSARY.

FUGITIVE DUST PLAN

The Contractor will fill out the form and file the original with the Division of Air Quality and a copy of the form with the Division of Facilities Construction & Management, prior to the issuance of any notice to proceed.

The Contractor will be fully responsible for compliance with the Fugitive Dust Control Plan, including the adequacy of the plan, any damages, fines, liability, and penalty or other action that results from noncompliance.

Utah Division of Air Quality

April 20, 1999

**GUIDANCE THAT MUST BE CONSIDERED IN DEVELOPING AND SUBMITTING A
DUST CONTROL PLAN FOR COMPLIANCE WITH R307-309-3, 4, 5, 6, 7**

Source Information:

1. Name of your operation (source): provide a name if the source is a construction site.
2. Address or location of your operation or construction site.
3. UTM coordinates or Longitude/Latitude of stationary emission points at your operation.
4. Lengths of the project, if temporary (time period).
5. Description of process (include all sources of dust and fugitive dust). Please, if necessary, use additional sheets of paper for this description. Be sure to mark it as an attachment.
6. Type of material processed or disturbed.
7. Amount of material processed (tons per year, tons per month, lbs./hr., and applicable units).

8. Destination of product (where will the material produced be used or transported, be specific, provide address or specific location), information needed for temporary relocation applicants.

9. Identify the individual who is responsible for the implementation and maintenance of fugitive dust control measures. List name(s), position(s) and telephone number(s).

10. List, and attach copies of any contract lease, liability agreement with other companies that may, or will, be responsible for dust control on site or on the project.

Description of Fugitive Dust Emission Activities
(Things to consider in addressing fugitive dust control strategies.)

1. Type of activities (drilling and blasting, road construction, development construction, earth moving and excavation, handling and hauling materials, cleaning and leveling, etc).
2. List type of equipment generating the fugitive dust.
3. Diagram the location of each activity or piece of equipment on site. Please attach the diagram.
4. Provide pictures or drawings of each activity. Include a drawing of the unpaved/paved road network used to move loads “on” and “off” property.
5. Vehicle miles travels on unpaved roads associated with the activity (average speed).
6. Type of dust emitted at each source (coal, cement, sand, soil, clay, dust, etc.)
7. Estimate the size of the release area at which the activity occurs (square miles). For haul or dirt roads include total miles of road in use during the activity.

Description of Fugitive Dust Emission Controls on Site

Control strategies must be designed to meet 20% opacity or less on site (a lesser opacity may be defined by Approval Order conditions or federal requirements such as NSPS), and control strategies must prevent exceeding 10% opacity from fugitive dust at the property boundary (site boundary) for compliance with R307-309-3.

1. Types of ongoing emission controls proposed for each activity, each piece of equipment, and haul roads.
2. Types of additional dust controls proposed for bare, exposed surfaces (chemical stabilization, synthetic cover, wind breaks, vegetative cover, etc).
3. Method of application of dust suppressant.
4. Frequency of application of dust suppressant.
5. Explain what triggers the use of a special control measure other than routine measures already in place, such as covered loads or measures covered by a permit condition (increase in opacity, high winds, citizen complaints, dry conditions, etc).
6. Explain in detail what control strategies/measures will be implemented off-hours, i.e., Saturdays/Sundays/Holidays, as well as 6 PM to 6 AM each day.

Description of Fugitive Dust Control Off-site

Prevent, to the maximum extent possible, deposition of materials, which may create fugitive dust on public and private paved roads in compliance with R307-309-5, 6, 7.

1. Types of emission controls initiated by your operation that are in place “off” property (application of water, covered loads, sweeping roads, vehicle cleaning, etc.).

2. Proposed remedial controls that will be initiated promptly if materials, which may create fugitive dust, are deposited on public and private paved roads.

Submit the Dust Control Plan to:

Executive Secretary
Utah Air Quality Board
POB 144820
15 North 1950 West
Salt Lake City, Utah 84114-4820

Phone: (801) 536-4000
FAX: (801) 536-4099

Fugitive Dust Control Plan Violation Report

When a source is found in violation of R307-309-3 or in violation of the Fugitive Dust Control Plan, the source must submit a report to the Executive Secretary within 15 days after receiving a Notice of Violation. The report must include the following information:

1. Name and address of dust source.
2. Time and duration of dust episode.
3. Meteorological conditions during the dust episode.
4. Total number and type of fugitive dust activities and dust producing equipment within each operation boundary. If no change has occurred from the existing dust control plan, the source should state that the activity/equipment is the same.
5. Fugitive dust activities or dust producing equipment that caused a violation of R-307-309-3 or the source's dust control plan.
6. Reasons for failing to control dust from the dust generating activity or equipment.
7. New and/or additional fugitive dust control strategies necessary to achieve compliance with R307-309-3, 4, 5, 6, or 7.
8. If it can not be demonstrated that the current approved Dust Control Plan can result in compliance with R307-309-3 through 7, the Dust Control Plan must be revised so as to demonstrate compliance with 307-309-3 through 7. Within 30 days of receiving a fugitive dust Notice of Violation, the source must submit the revised Plan to the Executive Secretary for review and approval.

Submit the Dust Control Plan to:

Executive Secretary	Phone: (801) 536-4000
Utah Air Quality Board	FAX: (801) 536-4099
POB 144820	
15 North 1950 West	
Salt Lake City, Utah 84114-4820	

Attachments: DFCM Form FDR R-307-309, Rule 307-309

CONTRACTOR'S AGREEMENT

FOR:

THIS CONTRACTOR'S AGREEMENT, made and entered into this ____ day of _____, 20__, by and between the DIVISION OF FACILITIES CONSTRUCTION AND MANAGEMENT, hereinafter referred to as "DFCM", and _____, incorporated in the State of _____ and authorized to do business in the State of Utah, hereinafter referred to as "Contractor", whose address is _____.

WITNESSETH: WHEREAS, DFCM intends to have Work performed at _____.

WHEREAS, Contractor agrees to perform the Work for the sum stated herein.

NOW, THEREFORE, DFCM and Contractor for the consideration provided in this Contractor's Agreement, agree as follows:

ARTICLE 1. SCOPE OF WORK. The Work to be performed shall be in accordance with the Contract Documents prepared by _____ and entitled "_____"

The DFCM General Conditions ("General Conditions") dated May 25, 2005 on file at the office of DFCM and available on the DFCM website, are hereby incorporated by reference as part of this Agreement and are included in the specifications for this Project. All terms used in this Contractor's Agreement shall be as defined in the Contract Documents, and in particular, the General Conditions.

The Contractor Agrees to furnish labor, materials and equipment to complete the Work as required in the Contract Documents which are hereby incorporated by reference. It is understood and agreed by the parties hereto that all Work shall be performed as required in the Contract Documents and shall be subject to inspection and approval of DFCM or its authorized representative. The relationship of the Contractor to the DFCM hereunder is that of an independent Contractor.

ARTICLE 2. CONTRACT SUM. The DFCM agrees to pay and the Contractor agrees to accept in full performance of this Contractor's Agreement, the sum of _____ DOLLARS AND NO CENTS (\$_____.00), which is the base bid, and which sum also includes the cost of a 100% Performance Bond and a 100%

CONTRACTOR'S AGREEMENT
PAGE NO. 2

Payment Bond as well as all insurance requirements of the Contractor. Said bonds have already been posted by the Contractor pursuant to State law. The required proof of insurance certificates have been delivered to DFCM in accordance with the General Conditions before the execution of this Contractor's Agreement.

ARTICLE 3. TIME OF COMPLETION AND DELAY REMEDY. The Work shall be Substantially Complete within _____ (____) calendar days after the date of the Notice to Proceed. Contractor agrees to pay liquidated damages in the amount of \$_____ per day for each day after expiration of the Contract Time until the Contractor achieves Substantial Completion in accordance with the Contract Documents, if Contractor's delay makes the damages applicable. The provision for liquidated damages is: (a) to compensate the DFCM for delay only; (b) is provided for herein because actual damages can not be readily ascertained at the time of execution of this Contractor's Agreement; (c) is not a penalty; and (d) shall not prevent the DFCM from maintaining Claims for other non-delay damages, such as costs to complete or remedy defective Work.

No action shall be maintained by the Contractor, including its or Subcontractor or suppliers at any tier, against the DFCM or State of Utah for damages or other claims due to losses attributable to hindrances or delays from any cause whatsoever, including acts and omissions of the DFCM or its officers, employees or agents, except as expressly provided in the General Conditions. The Contractor may receive a written extension of time, signed by the DFCM, in which to complete the Work under this Contractor's Agreement in accordance with the General Conditions.

ARTICLE 4. CONTRACT DOCUMENTS. The Contract Documents consist of this Contractor's Agreement, the Conditions of the Contract (DFCM General Conditions, Supplementary and other Conditions), the Drawings, Specifications, Addenda and Modifications. The Contract Documents shall also include the bidding documents, including the Notice to Contractors, Instructions to Bidders/Proposers and the Bid/Proposal, to the extent not in conflict therewith and other documents and oral presentations that are documented as an attachment to the contract.

All such documents are hereby incorporated by reference herein. Any reference in this Contractor's Agreement to certain provisions of the Contract Documents shall in no way be construed as to lessen the importance or applicability of any other provisions of the Contract Documents.

ARTICLE 5. PAYMENT. The DFCM agrees to pay the Contractor from time to time as the Work progresses, but not more than once each month after the date of Notice to Proceed, and only upon Certificate of the A/E for Work performed during the preceding calendar month, ninety-five percent (95%) of the value of the labor performed and ninety-five percent (95%) of the value of materials furnished in place or on the site. The Contractor agrees to furnish to the DFCM invoices for materials purchased and on the site but not installed, for which the Contractor requests payment and agrees to

CONTRACTOR'S AGREEMENT
PAGE NO. 3

safeguard and protect such equipment or materials and is responsible for safekeeping thereof and if such be stolen, lost or destroyed, to replace same.

Such evidence of labor performed and materials furnished as the DFCM may reasonably require shall be supplied by the Contractor at the time of request for Certificate of Payment on account. Materials for which payment has been made cannot be removed from the job site without DFCM's written approval. Five percent (5%) of the earned amount shall be retained from each monthly payment. The retainage, including any additional retainage imposed and the release of any retainage, shall be in accordance with UCA 13-8-5 as amended. Contractor shall also comply with the requirements of UCA 13-8-5, including restrictions of retainage regarding subcontractors and the distribution of interest earned on the retention proceeds. The DFCM shall not be responsible for enforcing the Contractor's obligations under State law in fulfilling the retention law requirements with subcontractors at any tier.

ARTICLE 6. INDEBTEDNESS. Before final payment is made, the Contractor must submit evidence satisfactory to the DFCM that all payrolls, materials bills, subcontracts at any tier and outstanding indebtedness in connection with the Work have been properly paid. Final Payment will be made after receipt of said evidence, final acceptance of the Work by the DFCM as well as compliance with the applicable provisions of the General Conditions.

Contractor shall respond immediately to any inquiry in writing by DFCM as to any concern of financial responsibility and DFCM reserves the right to request any waivers, releases or bonds from Contractor in regard to any rights of Subcontractors (including suppliers) at any tier or any third parties prior to any payment by DFCM to Contractor.

ARTICLE 7. ADDITIONAL WORK. It is understood and agreed by the parties hereto that no money will be paid to the Contractor for additional labor or materials furnished unless a new contract in writing or a Modification hereof in accordance with the General Conditions and the Contract Documents for such additional labor or materials has been executed. The DFCM specifically reserves the right to modify or amend this Contractor's Agreement and the total sum due hereunder either by enlarging or restricting the scope of the Work.

ARTICLE 8. INSPECTIONS. The Work shall be inspected for acceptance in accordance with the General Conditions.

ARTICLE 9. DISPUTES. Any dispute, PRE or Claim between the parties shall be subject to the provisions of Article 7 of the General Conditions. DFCM reserves all rights to pursue its rights and remedies as provided in the General Conditions.

ARTICLE 10. TERMINATION, SUSPENSION OR ABANDONMENT. This Contractor's Agreement may be terminated, suspended or abandoned in accordance with the General Conditions.

ARTICLE 11. DFCM'S RIGHT TO WITHHOLD CERTAIN AMOUNT AND MAKE USE THEREOF. The DFCM may withhold from payment to the Contractor such amount as, in DFCM's judgment, may be necessary to pay just claims against the Contractor or Subcontractor at any tier for labor and services rendered and materials furnished in and about the Work. The DFCM may apply such withheld amounts for the payment of such claims in DFCM's discretion. In so doing, the DFCM shall be deemed the agent of Contractor and payment so made by the DFCM shall be considered as payment made under this Contractor's Agreement by the DFCM to the Contractor. DFCM shall not be liable to the Contractor for any such payment made in good faith. Such withholdings and payments may be made without prior approval of the Contractor and may be also be prior to any determination as a result of any dispute, PRE, Claim or litigation.

ARTICLE 12. INDEMNIFICATION. The Contractor shall comply with the indemnification provisions of the General Conditions.

ARTICLE 13. SUCCESSORS AND ASSIGNMENT OF CONTRACT. The DFCM and Contractor, respectively bind themselves, their partners, successors, assigns and legal representatives to the other party to this Agreement, and to partners, successors, assigns and legal representatives of such other party with respect to all covenants, provisions, rights and responsibilities of this Contractor's Agreement. The Contractor shall not assign this Contractor's Agreement without the prior written consent of the DFCM, nor shall the Contractor assign any moneys due or to become due as well as any rights under this Contractor's Agreement, without prior written consent of the DFCM.

ARTICLE 14. RELATIONSHIP OF THE PARTIES. The Contractor accepts the relationship of trust and confidence established by this Contractor's Agreement and covenants with the DFCM to cooperate with the DFCM and A/E and use the Contractor's best skill, efforts and judgment in furthering the interest of the DFCM; to furnish efficient business administration and supervision; to make best efforts to furnish at all times an adequate supply of workers and materials; and to perform the Work in the best and most expeditious and economic manner consistent with the interests of the DFCM.

ARTICLE 15. AUTHORITY TO EXECUTE AND PERFORM AGREEMENT. Contractor and DFCM each represent that the execution of this Contractor's Agreement and the performance thereunder is within their respective duly authorized powers.

ARTICLE 16. ATTORNEY FEES AND COSTS. Except as otherwise provided in the dispute resolution provisions of the General Conditions, the prevailing party shall be entitled to reasonable attorney fees and costs incurred in any action in the District Court and/or appellate body to enforce this Contractor's Agreement or recover damages or any other action as a result of a breach thereof.

CONTRACTOR'S AGREEMENT
PAGE NO. 5

IN WITNESS WHEREOF, the parties hereto have executed this Contractor's Agreement on the day and year stated hereinabove.

CONTRACTOR: _____

Signature Date

Title: _____

State of _____)
County of _____)

Please type/print name clearly

On this ____ day of _____, 20____, personally appeared before me, _____, whose identity is personally known to me (or proved to me on the basis of satisfactory evidence) and who by me duly sworn (or affirmed), did say that he (she) is the _____ (title or office) of the firm and that said document was signed by him (her) in behalf of said firm.

(SEAL)

Notary Public

My Commission Expires _____

APPROVED AS TO AVAILABILITY
OF FUNDS:

Financial Manager, Date
Division of Facilities Construction
and Management

**DIVISION OF FACILITIES
CONSTRUCTION AND MANAGEMENT**

Manager - Date
Capital _____

APPROVED AS TO FORM:
ATTORNEY GENERAL
May 25, 2005
By: Alan S. Bachman
Asst Attorney General

APPROVED FOR EXPENDITURE:

Division of Finance Date

PERFORMANCE BOND

(Title 63, Chapter 56, U. C. A. 1953, as Amended)

That _____ hereinafter referred to as the "Principal" and _____, a corporation organized and existing under the laws of the State of _____, with its principal office in the City of _____ and authorized to transact business in this State and U. S. Department of the Treasury Listed (Circular 570, Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Reinsuring Companies); hereinafter referred to as the "Surety," are held and firmly bound unto the State of Utah, hereinafter referred to as the "Obligee," in the amount of _____ DOLLARS (\$ _____) for the payment whereof, the said Principal and Surety bind themselves and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written Contract with the Obligee, dated the _____ day of _____, 20____, to construct _____ in the County of _____, State of Utah, Project No. _____, for the approximate sum of _____ Dollars (\$ _____), which Contract is hereby incorporated by reference herein.

NOW, THEREFORE, the condition of this obligation is such that if the said Principal shall faithfully perform the Contract in accordance with the Contract Documents including, but not limited to, the Plans, Specifications and conditions thereof, the one year performance warranty, and the terms of the Contract as said Contract may be subject to Modifications or changes, then this obligation shall be void; otherwise it shall remain in full force and effect.

No right of action shall accrue on this bond to or for the use of any person or corporation other than the state named herein or the heirs, executors, administrators or successors of the Owner.

The parties agree that the dispute provisions provided in the Contract Documents apply and shall constitute the sole dispute procedures of the parties.

PROVIDED, HOWEVER, that this Bond is executed pursuant to the Provisions of Title 63, Chapter 56, Utah Code Annotated, 1953, as amended, and all liabilities on this Bond shall be determined in accordance with said provisions to the same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument this _____ day of _____, 20____.

WITNESS OR ATTESTATION:

PRINCIPAL:

By: _____

(Seal)

Title: _____

WITNESS OR ATTESTATION:

SURETY:

By: _____

Attorney-in-Fact (Seal)

STATE OF _____)
) ss.
COUNTY OF _____)

On this _____ day of _____, 20____, personally appeared before me _____, whose identity is personally known to me or proved to me on the basis of satisfactory evidence, and who, being by me duly sworn, did say that he/she is the Attorney in-fact of the above-named Surety Company and that he/she is duly authorized to execute the same and has complied in all respects with the laws of Utah in reference to becoming sole surety upon bonds, undertakings and obligations, and that he/she acknowledged to me that as Attorney-in-fact executed the same.

Subscribed and sworn to before me this _____ day of _____, 20____.

My commission expires: _____

Resides at: _____

NOTARY PUBLIC

Agency: _____
Agent: _____
Address: _____
Phone: _____

Approved As To Form: May 25, 2005
By Alan S. Bachman, Asst Attorney General

PAYMENT BOND

(Title 63, Chapter 56, U. C. A. 1953, as Amended)

KNOW ALL PERSONS BY THESE PRESENTS:

That _____ hereinafter referred to as the "Principal," and _____, a corporation organized and existing under the laws of the State of _____ authorized to do business in this State and U. S. Department of the Treasury Listed (Circular 570, Companies Holding Certificates of Authority as Acceptable Securities on Federal Bonds and as Acceptable Reinsuring Companies); with its principal office in the City of _____, hereinafter referred to as the "Surety," are held and firmly bound unto the State of Utah hereinafter referred to as the "Obligee," in the amount of _____ Dollars (\$ _____) for the payment whereof, the said Principal and Surety bind themselves and their heirs, administrators, executors, successors and assigns, jointly and severally, firmly by these presents.

WHEREAS, the Principal has entered into a certain written Contract with the Obligee, dated the _____ day of _____, 20____, to construct _____ in the County of _____, State of Utah, Project No. _____ for the approximate sum of _____ Dollars (\$ _____), which contract is hereby incorporated by reference herein.

NOW, THEREFORE, the condition of this obligation is such that if the said Principal shall pay all claimants supplying labor or materials to Principal or Principal's Subcontractors in compliance with the provisions of Title 63, Chapter 56, of Utah Code Annotated, 1953, as amended, and in the prosecution of the Work provided for in said Contract, then, this obligation shall be void; otherwise it shall remain in full force and effect.

That said Surety to this Bond, for value received, hereby stipulates and agrees that no changes, extensions of time, alterations or additions to the terms of the Contract or to the Work to be performed thereunder, or the specifications or drawings accompanying same shall in any way affect its obligation on this Bond, and does hereby waive notice of any such changes, extensions of time, alterations or additions to the terms of the Contract or to the Work or to the specifications or drawings and agrees that they shall become part of the Contract Documents.

PROVIDED, HOWEVER, that this Bond is executed pursuant to the provisions of Title 63, Chapter 56, Utah Code Annotated, 1953, as amended, and all liabilities on this Bond shall be determined in accordance with said provisions to the same extent as if it were copied at length herein.

IN WITNESS WHEREOF, the said Principal and Surety have signed and sealed this instrument this _____ day of _____, 20____.

WITNESS OR ATTESTATION:

PRINCIPAL:

By: _____ (Seal)

Title: _____

WITNESS OR ATTESTATION:

SURETY:

By: _____ Attorney-in-Fact (Seal)

STATE OF _____)
) ss.
COUNTY OF _____)

On this _____ day of _____, 20____, personally appeared before me _____, whose identity is personally known to me or proved to me on the basis of satisfactory evidence, and who, being by me duly sworn, did say that he/she is the Attorney-in-fact of the above-named Surety Company, and that he/she is duly authorized to execute the same and has complied in all respects with the laws of Utah in reference to becoming sole surety upon bonds, undertakings and obligations, and that he/she acknowledged to me that as Attorney-in-fact executed the same.

Subscribed and sworn to before me this _____ day of _____, 20____.

My commission expires: _____

Resides at: _____

NOTARY PUBLIC

Agency: _____
Agent: _____
Address: _____
Phone: _____

Approved As To Form: May 25, 2005
By Alan S. Bachman, Asst Attorney General



Division of Facilities Construction and Management

CHANGE ORDER # _____

CONTRACTOR: _____

AGENCY OR INSTITUTION: _____

PROJECT NAME: _____

PROJECT NUMBER: _____

CONTRACT NUMBER: _____

ARCHITECT: _____

DATE: _____

CONSTRUCTION CHANGE DIRECTIVE NO.	PROPOSAL REQUEST NO.	AMOUNT		DAYS	
		INCREASE	DECREASE	INCREASE	DECREASE

	Amount	Days	Date
ORIGINAL CONTRACT			
TOTAL PREVIOUS CHANGE ORDERS			
TOTAL THIS CHANGE ORDER			
ADJUSTED CONTRACT			

DFCM and Contractor agree that the terms, contract sum, scope of the Work and time specified in this Change Order shall constitute the full accord and satisfaction, and complete adjustment to the Contract and includes all direct and indirect costs and effects related to, incidental to, and/or reasonably implied from such change in the contract terms, sum, scope of the Work and time.

Contractor: _____

Date

Architect/Engineer: _____

Date

Agency or Institution: _____

Date

DFCM: _____

Date

Funding Verification: _____

Date

Page ____ of ____ page(s)

29



STATE OF UTAH - DEPARTMENT OF ADMINISTRATIVE SERVICES

Division of Facilities Construction and Management**DFCM****CERTIFICATE OF SUBSTANTIAL COMPLETION**

PROJECT _____ PROJECT NO: _____

AGENCY/INSTITUTION _____

AREA ACCEPTED _____

The Work performed under the subject Contract has been reviewed on this date and found to be Substantially Completed as defined in the General Conditions; including that the construction is sufficiently completed in accordance with the Contract Documents, as modified by any change orders agreed to by the parties, so that the State of Utah can occupy the Project or specified area of the Project for the use for which it is intended.

The DFCM - (Owner) accepts the Project or specified area of the Project as Substantially Complete and will assume full possession of the Project or specified area of the Project at _____ (time) on _____ (date).

The DFCM accepts the Project for occupancy and agrees to assume full responsibility for maintenance and operation, including utilities and insurance, of the Project subject to the itemized responsibilities and/or exceptions noted below:

The Owner acknowledges receipt of the following closeout and transition materials:

☐ Record Drawings ☐ O & M Manuals ☐ Warranty Documents ☐ Completion of Training Requirements

A list of items to be completed or corrected (Punch List) is attached hereto. The failure to include an item on it does not alter the responsibility of the Contractor to complete all the Work in accordance with the Contract Documents, including authorized changes thereof. The amount of _____. (Twice the value of the punch list work) shall be retained to assure the completion of the punch list work.

The Contractor shall complete or correct the Work on the list of (Punch List) items appended hereto within _____ calendar days from the above date of issuance of this Certificate. If the list of items is not completed within the time allotted the Owner has the right to be compensated for the delays and/or complete the work with the help of independent contractor at the expense of the retained project funds. If the retained project funds are insufficient to cover the delay/completion damages, the Owner shall be promptly reimbursed for the balance of the funds needed to compensate the Owner.

CONTRACTOR (include name of firm) by: _____
(Signature) DATE

A/E (include name of firm) by: _____
(Signature) DATE

USING INSTITUTION OR AGENCY by: _____
(Signature) DATE

DFCM (Owner) by: _____
(Signature) DATE

4110 State Office Building, Salt Lake City, Utah 84114
telephone 801-538-3018 • facsimile 801-538-3267 • <http://dfcm.utah.gov>

cc: Parties Noted
DFCM, Director

SECTION 02450 - CONSTRUCTION BARRICADE STANDARDS

PART 1 - GENERAL

1.1. GENERAL

- A. The purpose of this document is to define the responsibilities of the contractor working on the project pertaining to protection of their work and protection of the general public from the hazards of their work. They shall be used with standard safety practices and other safety requirements such as OSHA. They represent minimum requirements for barricades when enhanced barricade specifications are not included in bid documents. All barricades shall be highly visible. They shall be constructed and positioned to not be a hazard in any manner.
- B. Obtain permission from the Owner for all barricades requiring supports installed below surface grades. The contractor shall be responsible for restoring all damage to existing utilities, landscape and pavements resulting from installation of barricades. This includes damage done by pedestrians and/or vehicles when routed around barricades. Restoration shall meet the requirements of the Owner.

1.2. CONSTRUCTION LIMITS

- A. When the construction project is confined to a specific area, the entire area is to be fenced and gates used to control access. Fences shall be a minimum of six feet high and be constructed of all new materials. Fences shall be installed on straight, true lines with the fence fabric stretched taut. Posts supporting the fabric shall be sized to support the fabric, associated wind loads and be nonclimbable. Gates shall be locked with the contractor's lock and appropriate Owner locks.

1.3. EXCAVATIONS

- A. Open excavations within construction areas where perimeter fencing exists shall be barricaded by highly visible tape, sawhorse-type stands, cones, etc., to protect the contractor's employees and visitors to the site.
- B. Open excavations outside construction areas that are perimeter fenced or on projects without perimeter fencing shall be barricaded by high visibility (yellow) fences. Fences shall be a minimum of five feet high and be constructed of all new or like-new materials (Conwed lightweight safety fence or equal). Fences shall be installed on straight, true lines with the fence fabric stretched taut. Post (T-stakes or better) supporting the fabric shall be sized and spaced to support the fabric and associated wind loads. (See Traffic and Pedestrian Control below for additional requirements associated with this section.)
- C. Fencing for trench excavations shall barricade the trench, excavated material and material to be placed in the trench. As trenching work progresses, fencing around areas backfilled to grade and cleared of hazards may be moved to new locations requiring fencing. Materials shall not be reused if not in like-new condition.

1.4. TRAFFIC CONTROL

- A. Construction work will at times require temporary closure to vehicular access of parts of the facility. These temporary closures must be requested by the contractor in writing through the Owner. Requests must be made a minimum of seven days in advance of desired closure date. Every effort will be made to accommodate closure on desired date, but closure on date requested is not guaranteed.

1.5. PEDESTRIAN CONTROL

- A. When pedestrians are routed around construction areas, additional barricades will be required to prevent damage to adjacent landscaped areas. Barricades shall be placed to route pedestrians around affected areas using existing paved surfaces. These barricades shall meet the requirements for open excavations outside perimeter fences.
- B. When routing pedestrians around an area on existing pavements is shown to be a hardship, the contractor may provide temporary walking surfaces across existing landscaped areas. These surfaces shall be constructed of a durable material with a slip-resistant surface. The use and placement of temporary

walking surfaces shall be approved in advance by the Owner. The contractor shall restore all landscaped areas damaged by the placement of walkways.

1.6. PROTECTION OF EXISTING TREES/ VEGETATION

- A. Existing trees and vegetation located in and near construction areas that are to remain shall be protected. Barricades meeting the requirements for excavations outside perimeter fences shall be placed outside the drip line of these trees.
- B. Should limited space require the area within the drip line of the trees be used for maneuvering of vehicles or access to the project, then the following requirements shall be met: The area within the drip line of the tree shall be covered with weed barrier or similar construction fabric. A six-to eight-inch layer of gravel roadbase shall be placed over the fabric to distribute weight. When the area is no longer required for use by the contractor, the gravel and fabric shall be removed.
- C. Watering trees to maintain existing health is required of all contractors under all circumstances.

END SECTION 02450

SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Mechanical demolition.
 - 3. Equipment installation requirements common to equipment sections.
 - 4. Concrete bases.
 - 5. Supports and anchorages.

1.2 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

1.3 SUBMITTALS

- A. Welding certificates.

1.4 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2 - PRODUCTS

2.1 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 15 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.2 JOINING MATERIALS

- A. Refer to individual Division 15 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.
- F. Welding Filler Metals: Comply with AWS D10.12.
- G. Solvent Cements for Joining Plastic Piping:
 1. ABS Piping: ASTM D 2235.
 2. CPVC Piping: ASTM F 493.
 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 4. PVC to ABS Piping Transition: ASTM D 3138.

2.3 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.

- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F
- D. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

PART 3 - EXECUTION

3.1 MECHANICAL DEMOLITION

- A. Refer to Division 1 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.
 - 1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
 - 2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
 - 3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
 - 4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
 - 5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
 - 6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
 - 7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 15 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.
- Q. Verify final equipment locations for roughing-in.
- R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.3 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
 - 3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
 - 4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
 - 5. PVC Nonpressure Piping: Join according to ASTM D 2855.
 - 6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
 - 1. Plain-End Pipe and Fittings: Use butt fusion.
 - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.4 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
 - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
 - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
 - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.

3.6 CONCRETE BASES

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
 - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
 - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
 - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
 - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 5. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
 - 7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

END OF SECTION 15050

SECTION 15080 - MECHANICAL INSULATION

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes mechanical insulation for boiler breeching, duct, equipment, and pipe, including the following:
 - 1. Insulation Materials:
 - a. Cellular glass.
 - b. Flexible elastomeric.
 - c. Mineral fiber.
 - d. Polyolefin.
 - e. Polystyrene.
 - 2. Fire-rated insulation systems.
 - 3. Insulating cements.
 - 4. Adhesives.
 - 5. Mastics.
 - 6. Sealants.
 - 7. Factory-applied jackets.
 - 8. Field-applied fabric-reinforcing mesh.
 - 9. Field-applied jackets.
 - 10. Tapes.
 - 11. Securements.
 - 12. Corner angles.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show details for the following:
 - 1. Application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Attachment and covering of heat tracing inside insulation.
 - 3. Insulation application at pipe expansion joints for each type of insulation.
 - 4. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 5. Removable insulation at piping specialties, equipment connections, and access panels.
 - 6. Application of field-applied jackets.
 - 7. Application at linkages of control devices.
 - 8. Field application for each equipment type.
- C. Field quality-control inspection reports.

1.3 QUALITY ASSURANCE

- A. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 - 2. Products: Subject to compliance with requirements, provide one of the products specified.
 - 3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 INSULATION MATERIALS

- A. Refer to Part 3 schedule articles for requirements about where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products:
 - a. Cell-U-Foam Corporation; Ultra-CUF.
 - b. Pittsburgh Corning Corporation; Foamglas Super K.
 2. Block Insulation: ASTM C 552, Type I.
 3. Special-Shaped Insulation: ASTM C 552, Type III.
 4. Board Insulation: ASTM C 552, Type IV.
 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 6. Preformed Pipe Insulation with Factory-Applied: Comply with ASTM C 552, Type II, Class 2.
 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
1. Products:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
1. Products:
 - a. CertainTeed Corp.; Duct Wrap.
 - b. Johns Manville; Microlite.
 - c. Knauf Insulation; Duct Wrap.
 - d. Manson Insulation Inc.; Alley Wrap.
 - e. Owens Corning; All-Service Duct Wrap.
- I. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
1. Products:
 - a. Johns Manville; HTB 23 Spin-Glas.
 - b. Owens Corning; High Temperature Flexible Batt Insulations.
- J. Mineral-Fiber, Preformed Pipe Insulation:
1. Products:
 - a. Fibrex Insulations Inc.; Coreplus 1200.
 - b. Johns Manville; Micro-Lok.
 - c. Knauf Insulation; 1000 Pipe Insulation.
 - d. Manson Insulation Inc.; Alley-K.

- e. Owens Corning; Fiberglas Pipe Insulation.
 - 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
 - 3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
- K. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.
- 1. Products:
 - a. Knauf Insulation; Permawick Pipe Insulation.
 - b. Owens Corning; VaporWick Pipe Insulation.
- L. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.
- 1. Products:
 - a. CertainTeed Corp.; CrimpWrap.
 - b. Johns Manville; MicroFlex.
 - c. Knauf Insulation; Pipe and Tank Insulation.
 - d. Manson Insulation Inc.; AK Flex.
 - e. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.3 FIRE-RATED INSULATION SYSTEMS

- A. Description: High-temperature, flexible, blanket insulation with FSK jacket that is UL tested and certified to provide a 2-hour fire rating.
- 1. Products:
 - a. CertainTeed Corp.; FlameChek.
 - b. Johns Manville; Firetemp Wrap.
 - c. Nelson Firestop Products; Nelson FSB Flameshield Blanket.
 - d. Thermal Ceramics; FireMaster Duct Wrap.
 - e. 3M; Fire Barrier Wrap Products.
 - f. Unifrax Corporation; FyreWrap.
 - g. Vesuvius; PYROSCAT FP FASTR Duct Wrap.

- B. Materials shall be compatible with insulation materials, jackets, and substrates: Comply with MIL-C-19565C, Type II.

2.4 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
 - 1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 - 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 - 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 - 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
 - 5. PVDC Jacket for Indoor Applications: 4-mil- thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

2.5 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
 - 1. Products:
 - a. Johns Manville; Zeston.
 - b. P.I.C. Plastics, Inc.; FG Series.
 - c. Proto PVC Corporation; LoSmoke.
 - d. Speedline Corporation; SmokeSafe.
 - 2. Adhesive: As recommended by jacket material manufacturer.
 - 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
 - 4. Factory-fabricated tank heads and tank side panels.
- D. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105 or 5005, Temper H-14.
 - 1. Products:

- a. Childers Products, Division of ITW; Metal Jacketing Systems.
- b. PABCO Metals Corporation; Surefit.
- c. RPR Products, Inc.; Insul-Mate.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.2 COMMON INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation with tightly butted joints free of voids and gaps. Vapor barriers shall be continuous. Before installing jacket material, install vapor-barrier system.
- C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- D. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- E. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- F. Install multiple layers of insulation with longitudinal and end seams staggered.
- G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- H. Keep insulation materials dry during application and finishing.
- I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- J. Install insulation with least number of joints practical.
- K. Hangers and Anchors: Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- M. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches . Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- P. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- Q. For above ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.
- R. with flashing sealant.
1. "Through-Penetration Firestop Systems."

3.3 PIPE INSULATION INSTALLATION

- A. Requirements in this Article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Secure single-layer insulation with bands at 12-inch intervals and tighten bands without deforming insulation materials.
- C. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches . Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with bands at 12-inch intervals.
- D. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
- E. Cover segmented insulated surfaces with a layer of insulating cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
- F. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
- G. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- H. Insulation Installation on Straight Pipes and Tubes:
 - 1. Secure each layer of preformed insulation to pipe with wire or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
 - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 - 3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
 - 4. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
 - 5. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- I. Insulation Installation on Pipe Flanges:
 - 1. Install preformed pipe insulation to outer diameter of pipe flange.
 - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of same insulation material and thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch , and seal joints with flashing sealant.
5. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

J. Insulation Installation on Pipe Fittings and Elbows:

1. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
2. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

K. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
5. Install insulation to flanges as specified for flange insulation application.

L. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

M. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.4 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous UL-listed fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 7 Section "Through-Penetration Firestop Systems."

3.5 FIELD QUALITY CONTROL

- A. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements. Remove defective Work.
- B. Install new insulation and jackets to replace insulation and jackets removed for inspection. Repeat inspection procedures after new materials are installed.

3.6 BOILER BREECHING INSULATION SCHEDULE

- A. Exposed, Breeching and Connector Insulation: High-temperature mineral-fiber blanket 3 inches thick and 3-lb/cu. ft. nominal density.
- B. Repair any insulation damaged during new installation of equipment and controls.

3.7 EQUIPMENT INSULATION SCHEDULE

- A. Repair any insulation damaged during new installation of equipment and controls.

3.8 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Fire-suppression piping.
 - 2. Drainage piping located in crawl spaces.
 - 3. Below-grade piping.
 - 4. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.9 INDOOR PIPING INSULATION SCHEDULE

- A. Heating-Hot-Water Supply and Return, 200 Deg F and below: Mineral-fiber, preformed pipe, Type I, 1 inch thick.

END OF SECTION 15080

SECTION 15122 - METERS AND GAGES

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following meters and gages for mechanical systems:
 - 1. Flowmeters.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated; include performance curves.
- B. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FLOWMETERS

- A. Steam Flow Meters:
 - 1. Manufacturers:
 - a. GE Sensing
 - b. Approved equal
 - 2. Description: Fixed Installation Wetted Transit-Time Flowmeter for measuring mass flow rate of saturated or superheated steam with rangeability of 150 to 1. Microprocessor based with digital signal processing and cross correlation. Capable of displaying velocity, volumetric and mass flow data and to totalize flow in both directions. Flowmeter electronics housed in NEMA 4X IP66 enclosure with window. Flowmeter to have two independent software configurable LCD displays that show measurements simultaneously, with two standard 4-20 ma isolated outputs on the power loop.

Transducers to be wetted type, ultrasonic, capable of sending and receiving ultrasonic signals. Flow accuracy is to be 1%.

3. Pressure Rating: 300 psig minimum.
4. Temperature Rating: 500 deg F.
5. Range: Flow range of flow-measuring element and flowmeter shall cover operating range of equipment or system served.
6. Permanent Indicators: Suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having graphic display.
7. Provide with all necessary cables, spool sections, tubing for connecting to flowmeter element.
 - a. Scale: Pounds per hour.
 - b. Accuracy: Plus or minus 1 percent between 20 and 80 percent of range.
8. Operating Instructions: Include complete instructions with each flowmeter.
9. GE Sensing GS868 or approved equal

B. Natural Gas Flowmeters:

1. Manufacturers:
 - a. GE Sensing
 - b. Approved Equal
2. Description: Fixed Installation Wetted Transit-Time Flowmeter for measuring mass flow rate of natural gas with rangeability of 150 to 1. Microprocessor based with digital signal processing and cross correlation. Capable of displaying velocity, volumetric and mass flow data and to totalize flow in both directions. Flowmeter electronics housed in NEMA 4X IP66 enclosure with window. Flowmeter to have two independent software configurable LCD displays that can display up to four measurement parameters in sequence, with two standard 4-20 ma isolated outputs on the power loop. Transducers to be wetted type, ultrasonic, capable of sending and receiving ultrasonic signals. Flow accuracy is to be 1%.
3. Pressure Rating: 50 psig .
4. Range: Flow range of flow-measuring element and flowmeter shall cover operating range of equipment or system served.
5. Permanent Indicators: Suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having graphic display.
6. Provide with all necessary cables, spool sections, tubing for connecting to flowmeter element.
7. Accuracy: Plus or minus 1 percent for gases.
8. Operating Instructions: Include complete instructions with each flowmeter.
9. GE Sensing IGM868 or approved equal

C. Condensate and Make-up Water Flowmeters:

1. Manufacturers:

- a. GE Sensing
 - b. Approved Equal
2. Description: Fixed Installation Wetted Transit-Time Flowmeter for measuring mass flow rate of water with rangeability of 400 to 1. Microprocessor based with digital signal processing and cross correlation. Capable of displaying velocity, volumetric and mass flow data and to totalize flow in both directions. Flowmeter electronics housed in NEMA 4X IP67 enclosure with window. Flowmeter to have two independent software configurable LCD displays that can display up to four measurement parameters in sequence, with a standard 4-20 ma isolated output on the power loop. Transducers to be non-intrusive type, ultrasonic, capable of sending and receiving ultrasonic signals. Flow accuracy is to be 1%.
 3. Pressure Rating: 200 psig .
 4. Range: Flow range of flow-measuring element and flowmeter shall cover operating range of equipment or system served.
 5. Permanent Indicators: Suitable for wall or bracket mounting, calibrated for connected flowmeter element, and having graphic display.
 6. Provide with all necessary cables, spool sections, tubing for connecting to flowmeter element.
 7. Operating Instructions: Include complete instructions with each flowmeter.
 8. GE Sensing UTX878 or approved equal

PART 3 - EXECUTION

- A. Install flow indicators, in accessible positions for easy viewing, in piping systems.
- B. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions.
- C. Install flowmeter elements in accessible positions in piping systems.
- D. Install flowmeter elements with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.
- E. Install permanent indicators on walls or brackets in accessible and readable positions.
- F. Install connection fittings for attachment to portable indicators in accessible locations.
- G. Mount meters on wall if accessible; if not, provide brackets to support meters.
- H. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.
- I. Calibrate meters according to manufacturer's written instructions, after installation.
- J. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 15122

SECTION 15182 - STEAM AND CONDENSATE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes steam and condensate piping and specialties for systems up to 125 psig , inside the building.

1.3 DEFINITIONS

- A. HP Systems: High-pressure systems operating at greater than 15 psig.
- B. LP Systems: Low-pressure systems operating at less than 15 psig.

1.4 SYSTEM DESCRIPTION

- A. Steam and condensate piping for this Project is a two-pipe, mechanical flow, upfeed system.

1.5 SUBMITTALS

- A. Welding Certificates: Copies of certificates for welding procedures and personnel.

1.6 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

1.7 COORDINATION

- A. Coordinate pipe fitting pressure classes with products specified in related Sections.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. General: Refer to Part 3 piping application articles for applications of pipe and fitting materials.

2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe, NPS 2 and Smaller: ASTM A 53, Type S (seamless), Grade A, Schedules 40 and 80, black steel, plain ends.
- B. Steel Pipe, NPS 2-1/2 through NPS 12: ASTM A 53, Type E (electric-resistance welded), Grade A, Schedules 40 and 80, black steel, plain ends.
- C. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125, 150, and 300.
- D. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 and 300.
- E. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
- F. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250; raised ground face, and bolt holes spot faced.
- G. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- H. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.
 - 2. End Connections: Butt welding.
 - 3. Facings: Raised face.
- I. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.
- J. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

PART 3 - EXECUTION

3.1 LP STEAM PIPING APPLICATIONS

- A. Steam Piping, NPS 2 and Smaller: Schedule 40 steel pipe, with threaded joints using Class 125 cast-iron fittings.

- B. Steam Piping, NPS 2-1/2 through NPS 12 : Schedule 40 steel pipe, with welded joints using Schedule 40 wrought-steel welding fittings and Class 150 wrought-steel flanges.
- C. Condensate Piping, **NPS 2** and Smaller: Schedule 80 steel pipe, with threaded joints using Class 125 malleable-iron fittings.
- D. Condensate Piping, NPS 2-1/2 through NPS 12: Schedule 80 steel pipe, with welded joints using Schedule 80 wrought-steel welding fittings and Class 150 wrought-steel flanges.

3.2 HP STEAM PIPING APPLICATIONS

- A. Steam Piping, NPS 2 and Smaller: Schedule 40 steel pipe, with threaded joints using Class 300 malleable-iron fittings.
- B. Steam Piping, NPS 2-1/2 through NPS 12: Schedule 40 steel pipe, with welded joints using Schedule 40 wrought-steel welding fittings and Class 150 wrought-steel flanges.
- C. Condensate Piping, NPS 2 and Smaller: Schedule 80 steel pipe, with threaded joints using Class 300 malleable-iron fittings.
- D. Condensate Piping, NPS 2-1/2 through NPS 12: Schedule 80 steel pipe, with welded joints using Schedule 80 wrought-steel welding fittings and Class 150 wrought-steel flanges.

3.3 STEAM METER INSTALLATION

- A. Install lengths of straight pipe upstream and downstream from meters according to steam meter manufacturer's instructions.

3.4 FIELD QUALITY CONTROL

- A. Prepare steam and condensate piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Flush system with clean water. Clean strainers.
 - 3. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
- B. Perform the following tests on steam and condensate piping:
 - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 - 2. While filling system, use vents installed at high points of system to release trapped air. Use drip legs installed at low points for complete draining of liquid.
 - 3. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to

pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."

4. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
5. Prepare written report of testing.

3.5 CLEANING

- A. Flush steam and condensate piping with clean water. Remove and clean or replace strainer screens.

END OF SECTION 15182

SECTION 15194 - FUEL GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes fuel gas piping within the building. Products include the following:
 - 1. Pipe, tube, fittings, and joining materials.

1.2 PROJECT CONDITIONS

- A. Gas System Pressure: One pressure range. More than 2.0 psig but not more than 5.0 psig .

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NFPA Standard: Comply with NFPA 54, "National Fuel Gas Code."

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
- B. Steel Pipe: ASTM A 53/A 53M; Type E or S; Grade B; black. Wall thickness of wrought-steel pipe shall comply with ASME B36.10M.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern, with threaded ends according to ASME B1.20.1.
 - 2. Steel Threaded Fittings: ASME B16.11, forged steel with threaded ends according to ASME B1.20.1.
 - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends according to ASME B1.20.1.
 - 4. Cast-Iron Flanges and Flanged Fittings: ASME B16.1, Class 125.
 - 5. Joint Compound and Tape: Suitable for natural gas.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Close equipment shutoff valves before turning off fuel gas to premises or section of piping. Perform leakage test as specified in "Field Quality Control" Article to determine that all equipment is turned off in affected piping section.

3.2 PIPING APPLICATIONS

- A. Use flanges, unions, transition, and special fittings in applications below, unless otherwise indicated.
- B. Fuel Gas Piping 2 to 5 psig:
 - 1. Steel pipe, malleable-iron threaded fittings, and threaded joints.

3.3 INSTALLATION

- A. Basic piping installation requirements and piping joint construction are specified in Division 15 Section "Basic Mechanical Materials and Methods."

3.4 CONNECTIONS

- A. Install piping adjacent to appliances to allow service and maintenance.

3.5 FIELD QUALITY CONTROL

- A. Test, inspect, and purge piping according to NFPA 54 and requirements of authorities having jurisdiction. Repair leaks and defects with new materials and retest system until satisfactory results are obtained.

END OF SECTION 15194

SECTION 15515 - WATER-TUBE BOILERS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes Boiler Burner Management Control System only.

1.2 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For Controls and accessories. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and maintenance data.
- D. Warranty: Special warranty specified in this Section.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.4 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace burner controls that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Coen – BMS-2000 Burner Management System
 - 2. Approved Equal

2.2 CONTROLS

- A. Refer to Division 15 Section "HVAC Instrumentation and Controls."
- B. Boiler operating controls shall include the following devices and features:
 - 1. Burner Management System (BMS) utilizing programmable Logic Controller (PLC) to perform all programming, timing and switching functions. BMS to include dual flame safeguard, redundant flame scanner, first out annunciator, NEMA 4 rating, U.L. components, three water column relays, two scanner meters, dual fuel capability, low fire fuel changeover, auxiliary contacts as necessary for connection to the existing Honeywell Control System of the campus.
 - 2. Provide and install RCS electric actuator with 4-20 ma positioner and positioner feedback. To be installed by BMS provider.
 - 3. Sequence of Operation: PLC, factory-fabricated and field-installed panel to control burner firing rate and control.
- C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
- D. Building Management System Interface: Factory install hardware and software to enable building management system to monitor, control, and display boiler status and alarms to the existing Honeywell Building Management system.
 - 1. A communication interface with building management system shall enable building management system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building management system.

2.3 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 16 Sections.
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
 - 1. House in NEMA 4 enclosure.
 - 2. Wiring shall be numbered and color-coded to match wiring diagram.

2.4 SOURCE QUALITY CONTROL

- A. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- B. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.

PART 3 - EXECUTION

- A. Install electrical devices furnished with but not specified to be factory mounted.
- B. Install control wiring to field-mounted electrical devices.

3.2 CONNECTIONS

- A.
- B. Ground equipment according to Division 16 Section.
- C. Connect wiring according to Division 16 Section.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Operational Test: Start units to confirm proper unit operation. Adjust air-fuel ratio and combustion.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning units and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain BMS.

END OF SECTION 15515

SECTION 15520 - FEEDWATER EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes feedwater controllers and valves.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacity, temperature and NPSH required, pump performance curves with selection points clearly indicated, and furnished specialties and accessories.
- B. Shop Drawings: Include plans, elevations, sections, details, dimensions, weights, loadings, required clearances, method of field assembly, and attachments to other work.
 - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Operation and maintenance data.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 - PRODUCTS

2.1 FEEDWATER CONTROLLER

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Preferred – PCC III Multiple Loop Controller
 - 2. Approved Equal from Foxboro
- B. Description: Factory-assembled and -tested unit consisting of a PLC multiple loop controller including processor w:
 - 1. 5 - AI channels
 - 2. 2 - AO channels
 - 3. 5 – DI channels
 - 4. 2 – Relay output channels
 - 5. 4 – DO channels

- C. Drum Level Differential Pressure Transmitter Assembly:
 - 1. Material: Foxboro “Smart” transmitter, in NEMA 4 enclosure, 316L SS connection material, FM approved, mounting bracket with 3-valve manifold and steam pressure transmitter.
- D. Feedwater Control Valve:
 - 1. Material: Valtek Flowserver Mark One Control Valve
 - 2. Bronze valve body rated at 400 psi with stainless steel trim.
 - 3. XL90 positioner
- E. Building Management System Interface: Factory install hardware to enable building management system to monitor and display points: Boiler drum level

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install feedwater unit as per manufactures recommendations.
- B. Install unit to permit access for maintenance.
- C. Install parts and accessories shipped loose.
- D. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- E. Adjust boiler water-level controls to proper level.

3.2 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
 - 1. Inspect field-assembled components, equipment installation, and piping and electrical connections for compliance with manufacturer's written instructions.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 15520

15900 Building Energy Management System

Part 1 GENERAL

1. SUMMARY

A. SECTION INCLUDES:

1. Provide an integrated Building Energy Management System (BEMS) incorporating Direct Digital Control (DDC) Energy Management. The Building Energy Management System shall be integrated to provide the end users with full control, monitoring and management functions, based on a common computer operating system and operating procedures of all points installed on to the Building Energy management System.
2. A two-wire peer communication network to allow data exchange between primary controllers and centrals.
3. A personal computer (PC)-based central, with graphical user interface and associated operator station(s), and software functioning as the primary operator interface to the BEMS.
4. All system components shall be fault tolerant.
 - a. Provide satisfactory operation without damage at 110% and 85% of rated voltage and at + 3 Hz variation of line frequency.
 - b. Provide static, transient and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus-connected devices shall be transformer coupled or equivalent so that any single device failure shall not disrupt or halt bus communication.
7. All real time clocks and data file RAM should be capacitor-backed or battery-backed. The minimum life span for the battery shall be 30 days.

C. Typical diagrams of automatic control systems and description of sequence of operation of the systems are shown on the Drawings.

D. Products furnished but not installed under this Section:

1. Automatic Control Dampers
2. Air Flow Measuring Stations
3. Automatic Valves
4. Wells

E. Software Engineering Institute [SEI]

1. Certification Level 3

F. Industry Standards

1. Ethernet
2. TCP/IP Network Topology
3. ODBC Open Database
4. DDE - Dynamic Data exchange
5. OPC - OLE for Process Control
6. Echelon Corporation LonMark Interoperability Standard
7. Modicon Modbus

2. QUALITY ASSURANCE

A. CODES AND APPROVALS

1. The complete BEMS installation shall be in strict compliance to the national, state and local mechanical and electrical codes as applicable and all referenced sections of these specifications. All devices shall be UL or FM listed and labeled for the specific use, application and environment to which they are applied. The system shall be year 2000 compliant.
2. All electronic equipment shall conform to the requirements of FCC regulation Part 15 and the European CE standard governing radio electromagnetic emissions interference, and be so labeled. Spread spectrum components shall comply with FCC regulation part 15. 247 regarding low power unlicensed transmitters, and be so labeled.
3. Ensure that all safety switches, such as freeze protection thermostats and limit switches remain active under all operating conditions.
4. Ensure that all wiring, conduit, control devices and other electrical devices provided for any areas which are indicated as hazardous or in areas classified as hazardous by the National Electrical Code, the American Insurance Association, or the National Fire Protection Association meet all requirements for these classifications. Refer to the Electrical Drawings for area classifications.

- B. The final checkout and verification of complete and proper system operation shall be performed by technicians certified by the HVAC BMS manufacturer to be fully trained in the systems operation, installation, check-out, and maintenance. Detailed records of the check-out and verification procedures shall be maintained and submitted to owner's representative weekly. These records shall include the procedures used, the individuals performing the procedures, the dates and times, and the results.

- C. This Building Management Control System Specification must be conformed to in its entirety to ensure that the installed and programmed system will accommodate all of the current and future requirements of the building owner. Any specified item or operational feature not specifically addressed prior to bid date will be required to be met without exception.

D. QUALIFICATIONS

1. System Manufacturer must be Honeywell Branch 938 (801-978-7136).
2. System installer must be Honeywell Branch 938 (801-978-7136).

3. SYSTEM DESCRIPTION

- A. The BEMS provided under this section of the specifications shall consist of a distributed Client-Server, Local Area Network (LAN) based system, incorporating PC based Operator Workstations [OW] with dynamic multicolored graphic displays, a PC based Server, *an extension of the school district local area network*, routers, switchers, network nodes,

4. SUBMITTALS

- A. Provide 6 copies of submittal data within 90 days of contract award.

B. Certifications

1. Submit list of formal control manufacturer training for each individual involved in the project. Identify each product included in the training, the nature, length, date, and location of the training.

C. Submittal shall consist of:

1. System architecture showing all Operator Workstations, Server, routers, switchers, network nodes, direct digital controllers, UPS devices, and cable and power supply routing.
2. Control diagram for each system with a complete written sequence of operation.
3. Indicated in this documentation will be the type, size, rating, style, catalog number, manufacturer names, photo, and/or catalog data sheets for all items proposed to meet this specification.
4. Data entry forms for initial parameters. Contractor shall provide English listing of all process variable points with columnar blanks for high and low warning limits and high and low alarm limits, deviation high and low limits, transmitter high and low limits, and rate of change alarm, and a listing of all mechanical and electrical systems with columnar blanks for appropriate parameters; and samples of proposed text for points and messages (for at least two systems of at least 15 points total) including sample 480 character alarm message. All text shall be approved prior to data entry.
5. Wiring and piping interconnection diagrams including panel and device power and sources.
6. Sample sketches of all graphics operator displays, alarm displays, trend displays, and system displays.
7. Samples of all History record types and all report types.
8. Software design data including sample flowchart of each DDE, OPC, and DDC program showing interrelationship between inputs, PID functions, all other functions, outputs, etc. and sequence of operation relating to all flowchart functions.
9. Software License agreements for owner acceptance prior to software delivery.

5. TRAINING

- A. All training shall be provided by the BEMS contractor, utilizing operator manuals, as-built documentation, and operator workstations.
- B. Provide operator training for owner personnel consisting of one four hour sessions encompassing responding to alarms, events, messages, and incidents, the use of reports, displaying point information, monitoring system status, managing building control applications, area and alarm segregation, and operator set-up and password assignment.

6. WARRANTY

- A. All components, system software, parts, and installation supplied by the BEMS contractor shall be guaranteed against defects in materials and workmanship for one year from date of system acceptance. Labor to repair, reprogram, or replace components shall be furnished by the BEMS contractor at no charge during the warranty period. All corrective software modifications made during the warranty period shall be updated on all user documentation and on user and manufacturer archived software disks.
- B. All warranty work of a minor nature shall be performed during normal contractor work hours, Monday through Friday. Major warranty work, defined as, affecting more than 15% of the system, causing complete operator workstation or server failure, or work involving life safety or security shall be responded to within four hours. Major warranty work shall be performed regardless of normal work hours or days until corrected.

7. ACCEPTABLE BIDDERS

- G. Acceptable bidders on this project are Honeywell International Authorized Control Integrators. System to match existing system.

SUU BOILERS SYSTEM POINTS DISTRIBUTED CONTROL SYSTEM (DCS)

ITEM#	DISPLAY	QTY	LOCATION	COMMENTS
			each boiler/1-	
1	Steam Pressure	4	head	PGS100ANA1A
2	Drum level	3	each boiler	
3	Natural gas flow	1		GE
4	Natural gas supply pressure	1	each boiler	gas meter
5	Natural gas train pressure	3	each boiler	PGS100A14A1A
6	Stack temperature	3	each boiler	TE500H4C21A11H
7	Steam flow	3	each boiler	GE
8	Make-up water flow	1		GE
9	Condensate flow	3		GE
	Inside/outside temperature			T7770A1006,C7041F200
10	readings	1		6

11	Alarms	3	each boiler	Auxiliary contacts
12	Burner shutdown, i.e., fuel valve	3	each boiler	Auxiliary contacts
13	Indication of fuel selected, gas or oil	3	each boiler	Auxiliary contacts
14	Flame detection	3	each boiler	Auxiliary contacts
15	VFD's Boiler Feed Pumps	3	each boiler	2 QTY NXS0250B1009, 1QTY NXS0200B1000
ITEM#	ABLE TO CONTROL	QTY	LOCATION	COMMENTS
1	Steam pressure	1	head end	bias control from DCS
2	Electric feed water control	3	all boilers	drum sensor
3	Operator limits for steam pressure	1	head end	DCS programming
4	Local/remote control at unit	3	manual switch	DCS - can run manually

Also see Drawing Sheet M-601, "Control Item Legend" for more information on the above items.

SECTION 16010 - BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1. DESCRIPTION OF WORK:

- A. The extent of electrical work required is indicated in the Contract Documents which include but are not limited to, the following specification sections:

- | | | |
|-----|-------|---|
| 1. | 16010 | Basic Electrical Requirements |
| 2. | 16110 | Raceways |
| 3. | 16125 | Single Conductor Shielded Power Cable Rated 15 kV, EPR Type MV-90 |
| 4. | 16126 | Power Cable Installation Methods |
| 5. | 16127 | Cable Marking and Location |
| 6. | 16130 | Terminations and Splices |
| 7. | 16145 | Outdoor Padmount 15 kV Primary Metering Enclosure |
| 8. | 16150 | Grounding |
| 9. | 16235 | Electrical Boxes and Fittings |
| 10. | 16422 | Cast-in-place Concrete |
| 11. | 02450 | Construction Barricade Standards |

1.2. DEFINITIONS: The following are Division 16 document definitions:

- A. "Furnish": Purchase and deliver to project site.
- B. "Connect": Make all final electrical connections to a piece of equipment or device. This includes control wiring when shown or indicated.
- C. "Install": To furnish, connect and physically install the item.
- D. "Contract Documents": includes all applicable Division-16 drawings, specifications, and authorized changes (addendums, change orders, etc). They also include, but are not limited to, Architectural/Structural/Mechanical drawings, related Document/Section specifications and all authorized changes.

1.3. INTERPRETATION OF CONTRACT REQUIREMENTS

- A. Prior to bidding, the contractor shall review all applicable Contract Documents and shall make as many site visits as necessary to become completely familiarized with existing conditions and proposed construction requirements. Include all demolition/renovation/new construction costs in bid.
- B. Address all requests for clarification to the Owner/Engineer in writing five (5) working days prior to bid opening to allow issuance of the final addendum.
- C. After the contract has been awarded and signed, the Contractor shall fulfill the intent and purpose of the Contract Document requirements. All costs pertaining to equipment, material devices, testing and labor necessary for the completion of the job shall be the responsibility of the Contractor and shall be included in the bid.
- D. Additional costs due to inadequate site investigation or drawing/specification interpretation shall be the responsibility of the Contractor.
- E. Conflict of Requirements:
1. If a conflict of requirements is found between Division 16 and other Divisions/Sections, the more stringent requirement will take precedence.

1.4. ELECTRICAL IDENTIFICATION

- A. Apply equipment identification labels of engrave plastic-laminate on each major unit of electrical equipment.
 - 1. Provide a single line of text, with ½ inch high lettering on a 1-1/2 inch high label (2-1/2 inch high where two lines are required), white lettering in black field. Labels shall be attached with silicon rubber where screws are not possible due to oil or gas filled tanks.
 - 2. Text shall match terminology and numbering of the Contract Documents, shop drawings and Southern Utah University standard labeling methods.
- B. Each cable to be identified at its termination at each switch position. A listing of the cable and switch ID's will be provided by Southern Utah University.
 - 1. Cable labels shall be made of metal tags which are tie wrapped to the circuit feeder cables after fire tapping has been applied. Also see cable installation requirements for additional information.

1.5. CODE AND STANDARDS COMPLIANCE

- A. The most current published and adopted edition of the following codes, standards and references are considered part of this specification:
 - 1. Codes:
 - a. NEC - National Electric Code
 - b. NESC - National Electric Safety Code
 - c. NFPA - National Fire Protection Association
 - d. UBC - Uniform Building Code
 - e. UFC - Uniform Fire Code
 - f. UMC - Uniform Mechanical Code
 - 2. Standards:
 - a. AEIC - Association of Edison Illuminating Companies
 - b. ANSI - American National Standards Institute
 - c. ASTM - American Society for Testing Materials
 - d. ETL - Electrical Testing Laboratories
 - e. IEEE - Institute of Electrical and Electronics Engineers
 - f. IPCEA - Insulated Power Cable Engineers Association
 - g. NEMA - National Electrical Manufacturer's Association
 - h. UL - Underwriters' Laboratories
 - 3. All electrical equipment furnished under Division 16 shall comply with all current applicable NEMA requirements and shall be UL listed and labeled.
- B. State and Local Code Compliance
 - 1. The Contractor shall comply with all State and/or Local code requirements. If a conflict of requirements is found between those and the contract documents/specifications, the more stringent requirement will take precedence and shall be provided.
 - 2. The Contractor accepts responsibility for this upon bid submittal. All costs pertaining to this requirement shall be included in the bid and shall be the responsibility of the Contractor.

1.6. PERMITS/INSPECTIONS

- A. Obtain all permits, inspections, etc. pertaining to the completion of the job as required by the authority having jurisdiction and include all costs in the bid.
- B. Deliver all required certificates of approval to the Owner or Owners Representative upon completion of the project or upon the Owner's or Owner's Representative request.

1.7. QUALIFIED PERSONNEL/WORKMANSHIP

- A. The following are personnel/workmanship guidelines. They include, but are not limited to:
 - 1. The Contractor shall have an current applicable state contracting license for the type of work required under this contract.
 - 2. Provide a competent supervisor to oversee work at all times.
 - 3. Employ only qualified personnel with at least (3) years experience for the type of work required.
 - 4. Incompetent supervisors or personnel shall be discharged and replaced.
 - 5. Workmanship shall conform to the latest industry practices and shall have a neat, clean looking appearance.

1.8. MAINTENANCE AND OPERATION MANUALS

- A. Provide maintenance and operation manuals for all equipment provided under this Division in the following manner:
 - 1. Provide four (4) copies to the Engineer or Owner's Representative three weeks prior to completion of the project.
 - 2. Manuals shall include the following:
 - a. A cover letter indicating a complete list of equipment contained in the manual.
 - b. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
 - c. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; summer and winter operating instructions, wiring diagrams and certified outline and shop drawings.
 - d. Wiring diagrams, printed circuit card schematics, replaceable parts, manufacturer and catalogue numbers of items and equipment (sales cut sheets are not acceptable). Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
 - e. Servicing instructions and lubrication charts and schedules.
 - f. Names, addresses and phone numbers of vendors for each piece of equipment.
 - 3. All information shall be neat and legible.
 - 4. Manual binders shall have the project name on the binder spine. Location and the name and address of the contractor neatly labeled on a cover sheet inside the binder.
 - 5. Binders shall be appropriately sized to the information contained in it.
 - 6. All drawings shall be full drawn size. Provide one set of Diazo reproducible drawings, except 11" X 17" drawings may be Xerox reproducible.

1.9. RECORD DRAWINGS

- A. Drawing Requirements:
 - 1. Maintain a set of Record Drawings for the project in the following manner:
 - a. Show accurately dimensioned locations (from two reference points) of all buried or concealed work and equipment including, but not limited to, manholes, conduit, junction boxes, devices, etc. This includes change order and addendum items and all deviations from locations as shown on the Contract Documents.
 - b. Neatly labeled daily updates and instructions/information shall be made on a set of Contract Drawing blueprints.
 - 2. Provide Engineer with Field Record Drawings of applicable Contract Document drawings at the completion of the project and assist in the transfer of all the information from the field set of Record

Drawings in a neat, easily readable manner. Include notes and instructional information as required on the drawings to aid interpretation of project "as-built" conditions. Provide Southern Utah University with corrected originals for the project.

B. Certification

1. On of the first sheet of the mylar Record Drawings set, place the following certification statement:

The information contained in this set of "Record Drawings" is accurate and complete and hereby certified as correct.

(Name of General Contractor)

By:

Date:

(Name of Electrical Contractor)

By:

Date:

2. Persons with the authority are to sign and date this certification.

C. Delivery of Record Drawings

1. The complete and signed/dated set of Record Drawings shall be delivered to the Engineer no later than two (2) weeks after project completion.

1.10. STORAGE OF MATERIALS

- A. Store all materials in an area which will prevent damage. Completely cover to prevent accumulation or contact with dust, dirt, moisture or construction debris. Material damaged during storage or installation shall be repaired or replaced by the Contractor at no extra cost to the Owner.
- B. Store material in an area that will not block pedestrian or traffic flow; block or encroach upon exits or exit paths; or in a manner that could cause a safety hazard to anyone in the vicinity of the storage site.
- C. Material storage on site will be quite limited. Appropriate arrangements will need to be made with Southern Utah University to store materials.

PART 2 - PRODUCTS

2.1. GENERAL

- A. Products and materials are specified by manufacturer name, catalog number and/or by description.
- B. Referenced Manufacturers catalog numbers or descriptions establish the minimum quality of materials or systems required for project completion.
- C. Except for ordinary wear and tear, replace or repair all equipment, devices or materials which develop defects within one year of project completion.
- D. The contractor shall inform the Owner/Engineer in writing of any discrepancies found between the intended function of equipment and equipment specified in the Contract Documents a minimum of five (5) working days prior to issuance of the final addendum. Failure to report any discrepancy (catalog numbers, discontinued items, etc.) does not relieve the contractor from providing equipment which shall conform to and fulfill the intent of the Contract Documents. Nor shall it be used as a condition to obtain additional funds from the Owner after the Contract is awarded.
- E. Nameplates:

1. Each major component of equipment shall have a minimum the manufacturer's name, address, and catalog or style number on a nameplate securely attached to the item of equipment. Nameplates for individual items of electrical equipment shall be as specified in referenced publications and shall be provided on each item of equipment.

F. Prevention of Corrosion:

1. Metallic materials shall be protected against corrosion as specified. Aluminum shall not be used in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486B shall be used.
2. Ferrous metal hardware shall be hot dip galvanized in accordance with ASTM A 12, and A 153.
3. Rigid steel conduits installed in the earth shall be vinyl coated or field wrapped with .010 inch thick pipe wrapping plastic tape applied at a 50 percent overlay. Plastic tape is to be polyethylene or PVC with a minimum dielectric strength of 10,000 volts.

G. The Contractor shall request all clarifications of Contract Document requirements in writing to the Owner/Engineer a minimum of five (5) working days prior to issuance of the final addendum.

H. Upon request, provide samples of substitution or non-standard items.

I. Items may not be substituted after the bid opening.

2.2. PRODUCT DATA SUBMITTALS

A. Proof of Compliance:

1. Where materials or equipment are specified to conform to the standards or publications, and requirements of ANSI, ASTM, AEIC, IEEE, NEMA, NFPA, or UL, or to conform to a Fed Spec., the Contractor shall submit proof that the items furnished under this section of the specification conform to the specified requirements. The label of, or listing in the Electrical Construction Materials Directory of UL or the manufacturer's certification or published catalog specification data statement that the items comply with applicable specifications, standards, or publications and with the manufacturer's standards will be acceptable evidence of such compliance.

B. Shop Drawings:

1. After receiving complete material lists and before installation of any of these items, the Contractor shall submit complete shop drawings and such other descriptive data as the Engineer and Owner may require to demonstrate compliance with the contract documents. Shop drawings shall be submitted for the following items and such other items as the Engineer may direct:
 - a. Primary Cable - 15 kV
 - b. Cable Terminations
 - c. Metering Equipment
2. If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures, including changes in related portions of the project and the reasons therefore, shall be submitted with the shop drawings. Approved departures shall be made at no additional cost to the Owner.

C. List of Equipment and Materials:

1. A complete itemized listing of equipment and materials proposed for incorporation into the work shall be submitted. Each such itemization shall include an item number, the quantity of items proposed, the name of the manufacturer and catalog # of each such item.

D. Quality Standards

1. Prior to submitting Shop Drawings for review, the Contractor shall verify that items submitted comply with the functional intent, proportional and construction requirements of items indicated in the Contract Documents.
2. Equipment shall also comply with all required installation and operating clearances.

E. Submittal Procedures

1. Submit product data submittals for items as required per each section of this specification division.
2. Submit eight (8) copies of Product Data submittals for review prior to ordering or installing any equipment.

F. Submittal Content

1. Each submittal shall contain a cover sheet with the following information:
 - a. Name and location of the project.
 - b. Electrical Engineer, Contractor and Subcontractor names, addresses and phone numbers.
 - c. Supplier and/or Vendor name, address, and phone number.
 - d. Submittal date.
 - e. Revision or correction information.
2. Product data shall be published catalog material from the Manufacturer and shall contain the following information:
 - a. Complete dimensional, installation, and functional information including required options and special features.
 - b. Submittals shall only contain information relevant to equipment under review.
 - c. Catalog sheets shall have the Contract Document call out designation written on it in the upper right hand corner.
 - d. Each item under review shall have its own catalog sheet.
 - e. Shop Drawings shall contain detailed, $\frac{1}{4}" = 1' 0"$ scaled plans, sections and elevations which shall clearly indicate equipment and its relationship to adjacent equipment and/or structural elements (i.e. Spectrum Transformer installation).
3. Certification
 - a. The cover sheet shall contain the following statement:

The product data contained in this submittal has been thoroughly checked in all respects and complies with all requirements, performance intents and standards of the Contract Documents and Specifications for this project.

Signed _____

Date _____

G. Submittal Rejection

1. If the Product data and/or Shop Drawing submittals do not comply with the requirements contained in this section, they will be returned for resubmission.

H. Review Period

1. The Engineer has a minimum of two (2) weeks to review or re-review submittals after receiving them.

I. Contractor Responsibility

1. Review and/or acceptance of the Product Data and/or Shop Drawings submittals does not relieve the Contractor from the responsibility to provide materials and systems which satisfy the intent,

dimensional proportions, purpose and functional abilities of equipment or devices which are indicated on the Contract Documents.

2. The omission of noting errors or corrections by the Engineer on the submittals does not permit the Contractor to proceed in error or purchase, install or fabricate equipment or devices which do not satisfy the intent or requirements of the Contract Documents.
3. Regardless of any information contained in Product Data or Shop Drawings Submittals, requirements of the Contract Documents shall supersede any review of said submittals.

J. Job Site Verification

1. Upon arrival of equipment to the job site, the Contractor shall verify that the equipment complies with the requirements of the Contract Documents.

2.3. PRODUCT SUBSTITUTION SUBMITTAL

A. Substitutions will be considered only if the following requirements are met:

1. The Contractor shall supply two (2) copies of the proposed substitution submittal to the Owner/Engineer a minimum of five (5) working days prior to the bid date.
2. The submittal shall include:
 - a. A cover letter which lists proposed substitution items by manufacturer name and catalog number which are cross referenced to specified equipment in the Contract Documents.
 - b. Manufacturers published pictorial and specification material for proposed substitution items.
 - c. References of customers including names, addresses of those responsible for the use, installation, and maintenance of the proposed substitution.
 - d. Provide any additional information requested by the Engineer, in order for the Engineer to evaluate the substitution request.

B. Contractor Responsibility

1. Upon submission of a substitution submittal, the contractor automatically assumes responsibility that the proposed substitutions are equal to those items specified in the Contract Documents in performance, functional intent, voltage, ratings, construction design and is compatible in dimensional characteristics, etc.
2. Acceptance of substitution items does not relieve the Contractor from providing equipment which complies with the intent of the Contract Documents. If substitution equipment or material are judged to be inadequate by the Owner/Engineer after the contract is awarded, the Contractor shall replace that equipment or material with the originally specified items at no extra cost to the Owner.

C. Substitution Submittal Acceptance

1. Substitution Submittal acceptance will be issued only by addendum prior to the bid opening or by change order in the case of a discontinued item. Verbal acceptance by the Engineer will not be given nor shall conversations with the Engineer be construed as a basis to provide unapproved materials.

2.4. INCENTIVE BIDS

- A. Incentive bids are acceptable only if they are listed individually on the bid form as specific additions or deductions from the base bid and must be based on items specified or approved per addendum.

2.5. SPARE PARTS

- A. Provide all spare parts, lamps, fuses, etc., as required to the Owner/Owners Representative.

PART 3 - EXECUTION

3.1. ROUGH-IN

- A. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.
- B. Final location for equipment and pads shall be coordinated with Southern Utah University personnel.
- C. Refer to Manufacturers written equipment specifications for rough-in requirements.
- D. Contract Document Drawings are made at a small scale. Unless dimensions are indicated, equipment/devices are indicated in their approximate location. Coordinate locations with other trades and field verify all dimensions and locations.
- E. The Southern Utah University Personnel will provide all utility information available concerning the project work areas and surroundings.

3.2. ELECTRICAL INSTALLATIONS

- A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:
 - 1. Coordinate electrical systems, equipment, and materials installation with other building components or systems to avoid unnecessary cutting, drilling or channeling.
 - 2. Verify all dimensions by field measurements.
 - 3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for electrical installations.
 - 4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
 - 5. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.
 - 6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide code required headroom.
 - 7. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
 - 8. Install only approved systems, materials, and equipment. Conform to the intent of arrangements indicated by the Contract Documents. Portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Owner.
 - 9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other systems and components.
 - 10. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.
 - 11. The Contractor is responsible to verify the phase rotation before and after the meter enclosure is installed. The phase rotation before and after must match. Any damage to Southern Utah University Equipment resulting from reverse phase rotation will be the sole responsibility of the Contractor.
 - 12. Southern Utah University requires (in addition to the NEC requirements) a minimum of four foot (4') clearance in front of all electrical equipment or the clearance to swing the door 180 degrees, whichever is greater. Where high voltage cables are terminated, 10' of clear space shall be provided.

3.3. CUTTING AND PATCHING

- A. General: Perform cutting and patching in accordance with the following:
 - 1. Perform cutting, fitting, and patching of electrical equipment and materials required to:
 - a. Uncover Work to provide for installation of ill-timed Work.
 - b. Remove and replace defective Work.

- c. Remove and replace Work not conforming to requirements of the Contract Documents.
 - d. Remove samples of installed Work as specified for testing.
 - e. Install equipment and materials in existing structures.
 - f. Upon written instructions from the Engineer, uncover and restore Work to provide for Engineer observation of concealed Work.
2. Cut, remove, and legally dispose of selected electrical equipment, components, and materials as indicated, including but not limited to removal of electrical items indicated to be removed and items made obsolete by the new Work.
 3. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.
 4. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.
 5. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.
 6. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.
 7. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

3.4. EXCAVATIONS

A. The following definitions apply to excavation operations:

1. Additional Excavation: Where excavation has reached required subgrade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
2. Subbase: as used in this Section refers to the compacted soil layer used in pavement systems between the subgrade and the pavement base course material.
3. Subgrade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
4. Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction from the Engineer.

B. Conditions Affecting Excavations: The following project conditions apply:

1. Maintain and protect existing building services which transit the area affected by selective excavation.
2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
3. Site Information: The Owner will not be responsible for interpretations or conclusions drawn from any subsurface condition reports.
4. Existing Utilities: Locate existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations. Damages to existing utilities shall be repaired by the Contractor at no cost to the Owner.
5. Obtain a digging permit from Southern Utah University **before any excavation is begun**. The permit will show all known utilities.
6. Remove existing underground utilities indicated to be removed.
 - a. Uncharted or Incorrectly Charted Utilities: Contact utility owner immediately for instructions.
 - b. Provide temporary utility services to affected areas. Provide minimum of seven (7) working days notice to Owner and, if required, Utility Company prior to utility interruption. (Note: fourteen (14) days may be required for extended outages longer than two (2) hours.)
 - c. Proceed with utility interruption only after receiving written authorization from the owner and, if required, Utility Company. Keep all outages to a minimum.
 - d. Refer to the General Project Description and Requirements for outage request procedures and requirements.

7. Use of explosives is not permitted.
- C. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits permitted by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.
- D. Soil Materials
1. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, crushed slag, or natural or crushed sand.
 2. Drainage Fill: Washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, with 100 percent passing a 1-1/2-inch sieve, and not more than 5 percent passing a No. 4 sieve.
 3. Backfill and Fill Materials: Excavated or borrow material complying with ASTM D2487 soil classification groups GW or SW, with the fine fraction between 5%-10% and free from stones in excess of 2" in any dimension; debris; waste; frozen materials; and organic or other deleterious matter.
- E. Excavation Procedures
1. Protect persons at excavation sites by providing barricades, warning signs and lights as necessary to prevent personal injury or equipment damage.
 2. Slope sides of excavations to comply with local codes and ordinances. Shore and brace as required for stability of excavation.
 3. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
 - a. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.
 4. Install sediment and erosion control measures in accordance with local codes and ordinances.
 5. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
 - a. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
 - b. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches.
 6. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
 - a. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
 - b. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.
 7. Trenching: Excavate trenches for electrical installations as follows:
 - a. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of 6 to 9 inches clearance on both sides of raceways and equipment.
 - b. When conduits are installed between manholes, they shall be graded to drain towards the manholes whenever possible. The minimum slope necessary to accomplish this is three (3) inches per 100 feet of conduit.
 - c. Excavate trenches to depth indicated or required per NEC 300-5 or State requirements, whichever is the most stringent. (36" minimum to top of concrete, except by written approval when 30" to the top of the duct or conduit may be permitted for conflicts.)
 - d. Limit the length of open trench to that in which installations can be made and the trench backfilled within the same day.

- e. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceways and equipment. Provide a minimum of 6 inches of stone or gravel cushion between rock bearing surface and electrical installations.
8. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 deg F (2 deg C).
 9. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.
 - a. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
 - b. Under building slabs, use drainage fill materials.
 - c. Under piping and equipment, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
 - d. No raceways shall be installed less than 30 inches below surface of groundline, sidewalks or roadways.
 - e. Other areas, use excavated or borrowed materials.
 10. Backfill excavations as promptly as work permits, but not until completion of the following:
 - a. Inspection, testing, approval, and locations of underground utilities have been recorded.
 - b. Removal of concrete formwork.
 - c. Removal of shoring and bracing, and backfilling of voids.
 - d. Removal of trash and debris.
 11. Placement and Compaction: Place and compact backfill and fill materials in layers of 8 inch maximum lifts. Thinner lifts may be required depending on materials and compaction effort.
 12. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
 13. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.
 14. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below.
 - a. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (friction-cohesive soils), determined in accordance with ASTM D 1557.
 - (1) Areas Under Structures, Building Slabs, Walks and Steps, Pavements: Scarify and compact top 12 inches of subgrade and each layer of backfill or fill material to 95 percent maximum density for friction-cohesive material.
 - (2) Other Areas: Scarify and compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for friction-cohesive soils.
 - b. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.
 - c. The Contractor is responsible for the ultimate success of the compaction effort and overall project quality control. The Owner will perform tests to verify and monitor the soil compaction periodically. The presence of the Owners testing personnel and their findings does not relieve the Contractor of responsibility for the unsuccessful performance of the fill and compaction portion of the work. The cost of the first test performed in each area by the Owners testing representative will be paid by the Owner. However, cost of failed tests will be deducted from the Contractors pay request and/or retention fund. The Contractor is to notify the Engineer two (2) days prior to backfilling operations to allow for arrangements of testing personnel to be on site. The Contractor

is to cooperate and work with the Engineer and soil testing personnel by providing clear and convenient access to the work at any time while the compaction work is being performed.

d. A test schedule for all improvements shall be specified.

- (1) Curb and gutter with grade less than 0.5%: one random test per lift per 200 lineal feet.
- (2) Curb and gutter with grade greater than 0.5%: one random test per lift per 400 lineal feet.
- (3) Sidewalk: one random test per lift per 400 lineal feet.
- (4) Trenches: one random test per lift per 200 lineal feet.
- (5) Roadways: one random test per lift per 1000 square yards.
- (6) Landscape Areas: no specific requirements.

15. Subsidence: Where subsidence occurs at electrical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

16. Refer to Section 02480 and 02810 for landscape and irrigation restoration requirements.

3.5. FIRE PENETRATION SEALS

- A. Seal all penetrations through fire rated floors, ceilings, or walls for work required under this Division to prevent the spread of fire, toxic gases, smoke, or water through the seal either before, during or after a fire per NEC 300-21.
- B. The fire rating of the seal shall match or exceed that of the floor, wall or ceiling which it serves.
- C. Comply with all manufacturers written instructions pertaining to the use and installation requirements of fire seal/barrier products and/or systems.

3.6. INACCESSIBLE EQUIPMENT

- A. Where the Engineer determines that the Contractor has installed equipment not "conveniently" accessible for operation and maintenance, equipment shall be removed and reinstalled as directed at no additional cost to the Owner.
- B. "Conveniently accessible" is defined as being capable of being reached without the unnecessary use of ladders, and without unnecessary climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, and ductwork.

3.7. UTILITY DISRUPTIONS

- A. Utility disruptions (power, telephone, etc.) required for the completion of the project shall be coordinated in the following manner:
 1. For outages two (2) hours or less, contact the Owner a minimum of seven (7) working days prior to the proposed outage in writing.
 2. For outages more than two (2) hours, contact the Owner a minimum of fourteen (14) working days prior to the proposed outage in writing.
 3. Outage to be coordinated and scheduled at a time convenient with the owner.
 4. Obtain written permission from Southern Utah University before disrupting the service.
 5. Include all overtime costs for this requirement in the bid.
 6. It is anticipated that building shut downs for primary connection change over and other work requiring building outages will need to be performed during non-standard working hours.
 7. All cable switching procedures must be approved and will be coordinated with Southern Utah University personnel.
 8. Refer to General Project Description and Requirements for other outage and switching requirements.

PART 4 - PROJECT COMPLETION AND START-UP

4.1. SYSTEMS CERTIFICATION

- A. Assemble all applicable equipment Factory Representatives and Subcontractors at the project site for systems start-up and testing.
- B. Representatives shall assist in their respective system's start-up and testing and shall remain until their system has been accepted by the Owners Representative.
- C. The Factory Representative shall also personally instruct the Owners maintenance and/or operation personnel to the operation and maintenance of their equipment.
- D. The Owners Representative shall receive complete instruction pertaining to the operation and maintenance of all systems involved.
- E. The Contractor shall prepare a written certification as follows:

This certifies that the system subcontractor and Factory Representative listed below have fully instructed the Owners Representative and operational/maintenance personnel to the use and maintenance of their respective systems.

SYSTEM

(List systems)

FACTORY REPRESENTATIVE

(List names and addresses)

Owners Representative

Date

Contractor

Date

- F. One copy of this signed and dated certification shall be sent to the Engineer. The original shall be given to the Owners Representative.

4.2. FINAL REVIEW

- A. During the final project review, the Project Foreman shall accompany the reviewing party and, upon request, remove coverplates, panel covers, etc. to allow inspections of any portion of the electrical system.

END OF SECTION 16010

SECTION 16110 - RACEWAYS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions apply to this Section.
- B. This is a Division 16 Basic Materials and Methods section and is a part of each Division 16 section referencing to raceways specified in this section.

1.2. SUMMARY

- A. This Section includes raceways for electrical wiring. Types of raceways in this section include the following:
 - 1. Rigid galvanized conduit (RGC).
 - 2. Electrical metallic tubing (EMT).
 - 3. Rigid nonmetallic conduit (RNC).
 - 4. Ductbanks

1.3. SUBMITTALS - None Required.

1.4. QUALITY ASSURANCE

- A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."
- B. NEMA Compliance: Comply with applicable requirements of NEMA standards pertaining to raceways.
- C. UL Compliance and Labeling: Comply with applicable requirements of UL standards pertaining to electrical raceway systems. Provide raceway products and components listed and labeled by UL, ETL, or CSA.

1.5. MANUFACTURERS

- A. Provide raceways and raceway components from firms regularly engaged in manufacturing the types of raceway indicated and/or required and whose products have been used satisfactorily in similar usage for a minimum of five (5) years.

PART 2 - PRODUCTS

2.1. METALLIC CONDUIT AND TUBING

- A. Provide conduit in sizes indicated on drawings and/or specifications with all required fittings, bushings, couplings, etc. Minimum conduit trade size allowable is 3/4".
- B. Rigid Galvanized Conduit (RGC): ANSI C80.1.

Note: Aluminum conduit is not acceptable for any application.
- C. Electrical Metallic Tubing and Fittings: ANSI C80.3

2.2. UNDERGROUND METALLIC CONDUIT

- A. Portions of the ductbanks for conductors are to be direct buried rigid galvanized conduit. These conduits

shall have a protective coat of spirally wrapped PVC tape or a factory applied vinyl coat. Completely wrap and tape all field joints. Provide spacers as needed to allow for proper duct bank installation, backfill, and function.

2.3. NONMETALLIC CONDUIT AND DUCTS

- A. Rigid Nonmetallic Conduit (RNC): NEMA TC 2 and UL 651, Schedule 40 or 80 PVC.
- B. Underground PVC and ABS Plastic Utilities Duct: Schedule 40 or 80 PVC for encased burial in concrete.
- C. PVC and ABS Plastic Utilities Duct Fittings: NEMA TC 9; match to duct type and material.
- D. Conduit, Tubing, and Duct Accessories: Types, sizes, and materials complying with manufacturer's published product information. Mate and match accessories with raceway.
- E. All PVC conduit shall be rated for use with 90EC conductors.

2.4. CONDUIT BODIES

- A. General: Types, shapes, and sizes as required to suit individual applications and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.
- B. Metallic Conduit and Tubing: Use metallic conduit bodies. Use bodies with threaded hubs for threaded raceways.
- C. Conduit Bodies 1 Inch and Smaller: Use bodies with compression- type EMT connectors.
- D. Nonmetallic Conduit and Tubing: Use nonmetallic conduit bodies conforming to UL 514 B.

2.5. DUCTBANK CONSTRUCTION

- A. Ductbanks shall be concrete encased to be constructed as indicated using 2,500 psi at 28 day strength concrete. Use Type II low alkali per ASTM C150 and ASTM C-33 aggregate gradation with a maximum size of 3/4". Water/concrete ratio to be 0.50. Where "cold" joints occur in the concrete placement install #4 reinforcing bar per ASTM 615 grade 50 in each corner of the ductbank. Provide 200 lb. polypropylene pullrope in each spare duct with an excess of 48" at each end.
- B. Duct and Conduit Caulking Compound: Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees F., shall not slump at a temperature of 300 degrees F., and shall not harden materially when exposed to the air. Compounds shall readily calk or adhere to clean surfaces of asbestos-cement, fiber, or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials. Provide plastic plugs in both ends of all unused ducts and seal with silicon sealant.
- C. Duct and Fittings, Nonmetallic Type for Installation Underground: Wall thickness and fittings shall be suitable for the application. Ducts shall be single, round-bore type. Ducts shall be of the same material when used for applications requiring the same type of wall thickness.
- D. Requirements: Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 4 inches per 100 feet. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Manufactured 90 degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable and shall be galvanized steel. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3 inch diameter, and 36 inches for ducts 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends as required, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts

shall be provided with malleable steel end bells whenever duct lines terminate in switches or handholes. All bell ends shall be grounded. Duct line markers shall be provided as indicated at the ends of long duct line stubouts or for other ducts whose locations are indeterminate because of duct curvature or terminations at completely below-grade structures.

- E. Treatment: Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. After a duct line is completed, a standard flexible mandrell shall be used for cleaning followed by a brush with stiff bristles. Mandrels shall be at least 12 inches long and have diameters 1/4 inch less than the inside diameter of the duct being cleaned. Mandrel pulls shall be witnessed by the engineer and Southern Utah University representative. Engineer should inspect duct bank construction before concrete is poured. Provide polypropylene pull rope in each unused duct. Pneumatic rodding may be used to draw in lead wires. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.
- F. Installation of Couplings: Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved. In the absence of specific recommendations, various types of duct joint couplings shall be made watertight as specified.
 - 1. Plastic Duct: Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Solvent to be a two part solvent weld of the slow setting type for ducts over three (3) inches. Each duct and fitting shall then be slipped together with a quick one quarter turn twist to set the joint tightly.
- G. Raceways penetrating foundations, slabs on grade, footings, etc. shall be RGC with a plastic wrap or vinyl coating for a minimum of 10 feet beyond the structural element before a transition to PVC is permitted.
- H. Use O-Z/Gedney (or equal) conduit sealing bushing for all concrete wall penetrations.

PART 3 - EXECUTION

3.1. WIRING METHOD

- A. Outdoors: Use the following wiring methods:
 - 1. Exposed: rigid galvanized conduit.
 - 2. Underground: rigid nonmetallic conduit, and as indicated on drawings.
 - 3. Connection to Vibrating Equipment: Including hydraulic, pneumatic or electric solenoid or motor-operated equipment: liquidtight flexible metal conduit.
- B. Indoors: Use the following wiring methods:
 - 1. Use conduit type indicated in the drawings.
 - 2. Exposed: electrical metallic tubing.
 - 3. Concealed: electrical metallic tubing, electrical nonmetallic tubing, or rigid nonmetallic conduit.
 - 4. All new conduits installed in the Southern Utah University vaults for high voltage cables shall be RGC.

3.2. INSTALLATION

- A. General: Install electrical raceways in accordance with manufacturer's written installation instructions, applicable requirements of NEC, NECA, and as follows:
- B. Complete installation of electrical raceways before starting installation of conductors within raceways.

- C. Provide supports for raceways as required elsewhere in Division 16.
- D. Prevent foreign matter from entering raceways by capping ends.
- E. Protect stub-ups from damage where conduits rise from floor slabs. Arrange so curved portion of bends is not visible above the finished slab.
- F. Do not exceed manufacturer's written instructions concerning maximum bending radius limits. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.
- G. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location.
- H. Run concealed raceways with a minimum of bends in the shortest practical distance.
- I. Where nonmetallic conduit or tubing is used, raceways must be converted to RGC before rising above equipment or floor slab.
- J. Install exposed raceways parallel and perpendicular to nearby surfaces or structural members and follow the surface contours as much as practical.
- K. Join raceways with fittings designed and approved for the purpose and make joints tight. Make raceway terminations tight. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors.
- L. Tighten set screws of threadless fittings with suitable tool.
- M. Terminations: Where raceways are terminated with locknuts and bushings, align the raceway to enter squarely and install the locknuts with dished part against the box. Where terminations cannot be made secure with one locknut, use two locknuts, one inside and one outside the box.
- N. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.
- O. Install pull wires in empty raceways. Use no. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb tensile strength. Leave not less than 48 inches of slack at each end of the pull wire.
- P. Stub-up Connections: Extend conduits through concrete equipment or floor slabs for connection to freestanding equipment with an adjustable top or coupling threaded inside for plugs and set flush with the finished floor. Extend conductors to equipment with RGC.
- Q. Flexible Connections: Use short length (maximum of 6 ft.) of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet locations. Install dedicated ground conductor in flexible conduit.
- R. Comply with NEC requirements concerning pullbox installations.
- S. Minimum burial depths of concrete encased conduit shall be a minimum of 36" (30" by approval only) or comply with NEC Section 300-5; whichever is the most stringent per the application.
- T. Provide rigid galvanized conduit (RGC) for all elbows and offsets in duct runs. Metal raceway in direct contact with earth or fill of any kind shall have a protective coat of spirally wrapped PVC tape or a factory applied vinyl coat. Completely wrap and tape all field joints. All bends for buried conduits must be approved by the Engineer before installation. Only wide sweeps where shown on the drawings are allowed, and should be formed with the "natural" bend of the PVC conduit, unless approved otherwise.

- U. All conduits shall have a 6" wide yellow plastic marker tape placed 12" above the top of conduit bank the entire length of the conduit. Tape shall indicate "Electric Line Below".

3.3. ADJUSTING AND CLEANING

- A. Upon completion of installation of raceways, inspect interiors of raceways; clear all blockages and remove burrs, dirt, and construction debris. Replace all crushed, deformed or damaged raceways prior to installing wiring.

END OF SECTION 16110

PART 1 - GENERAL

1.1. SCOPE

- A. This specification covers single conductor shielded power cable insulated with an ozone and discharge resistant, flexible, rubber-like thermosetting dielectric.
 - 1. The cable shall be suitable for use in wet and dry locations in conduit, underground duct systems, direct buried and aerial installations. The cable shall be rated 90C for normal operation, 130C for emergency overload operation and 250C for short circuit conditions. Emergency overload operation may occur for periods up to 1,500 hours cumulative during the life of the cable.

1.2. OPERATING EXPERIENCE

- A. The medium voltage power cable supplied shall have a performance record demonstrating a minimum of twenty (20) years successful operation experience in utility and industrial power cable applications.

1.3. BASIC CONSTRUCTION

- A. MC-90-1/C Class B strand copper conductor, triple tandem extruded semiconducting rubber strand shield, EPR Insulation extruded, semiconducting rubber insulation shield, copper shield tape and a jacket overall.

1.4. INDUSTRY STANDARDS

- A. Cables shall meet or exceed the applicable latest editions of the following industry specifications:
 - 1. ICEA S-68-516 (up to 35kV)
 - 2. ASTM B-8, B-231
 - 3. AEIC CS-6
 - 4. UL-1072 (Type MV-90)
 - 5. IEEE 400-1980
 - 6. NEMA WC7, WC8
 - 7. Federal Register, Section 10CFR50, Appendix B
 - 8. ANSI N45.2
 - 9. IEEE 48-1990
 - 10. IEEE/IPCEA Power Cable Ampacities, IEEE S-135
 - 11. AEIC-I-68

1.5. SUBMITTALS

- A. Product Data: Submit manufacturer's data on electrical cable and connectors for use at the specified voltage. Submit certificate of compliance indicating that cable has been tested in accordance with ICEA S-68-516, AEIC CS6 and UL Standard 1072, and meets or exceeds minimum requirements.
- B. Installed Cable Field Test Data: Submit test data in accordance with IEEE Standard 400-1980 showing ambient conditions, voltage levels, level durations and conduction current for each step. Include effective insulation resistance in submittal.

PART 2 - PRODUCTS EPR CABLES

2.1. CONDUCTOR

- A. Uncoated soft copper wire, Class B, stranded compressed concentric round. Copper per ASTM B-8.
- B. Conductors shall meet the electrical resistance requirements of ICEA S-68-516, Section 2.5.

2.2. CONDUCTOR SHIELD

- A. Extruded layer of semiconducting EPR thermosetting compound with a volume resistivity not in excess of 10 ohm meters at 90C shall be applied over the conductor. The compound shall have a minimum elongation after an air over test at 121C for 168 hours of 100% and a brittleness temperature not warmer than -50C.
- B. The shield shall be clean stripping from the conductor and inseparably bonded to the overlying insulation.
- C. The thickness of the extruded conductor shield shall be as shown in Table I. The thickness of the shield shall be measured and controlled by means of a laser detector.

TABLE I Conductor Shield Thickness		
<u>Conductor Size - AWG/kcmil</u>	<u>Min. point (mils)</u>	<u>Min. Average (mils)</u>
8 - 4/0	12	15
250 - 500	16	20
600-1000	20	25

2.3. INSULATION

- A. The insulation shall be based on an ethylene propylene elastomer. The ethylene content of the elastomer used in the insulation compound shall not exceed 72% by weight. Any processing agent utilized to mix the formulation shall be widely dispersed to prevent susceptibility to treeing. The insulation shall be compounded by the cable manufacturer in its own facility using a closed system to insure maximum cleanliness. All ingredients shall be thoroughly mixed and treated with the accelerator or cross linking agent to insure complete blending and uniformity of the final compound.
- B. The minimum average insulation thickness shall not be less than Table II. The minimum thickness at any cross section of the insulation shall not be less than 90% of the specified minimum average thickness.
- C. The insulation shall be triple tandem extruded with the conductor and insulation shield to prevent intersurface contamination. The extrusion operation shall be performed by three separate in line extruded heads thereby permitting the measurement and accurate individual control of the wall thickness of each layer of compound as the cable is being manufactured.

TABLE II Minimum Average Insulation Thickness				
<u>Rated Voltage Phase to Phase kV</u>	<u>Conductor Size</u>	<u>mils - 133%</u>	<u>5 minute ac Withstand KV</u>	<u>15 minute dc Withstand kV</u>
15	#2 to 1,000 MCM	220	44	80

2.4. INSULATION SHIELD

- A. The insulation shield shall be an extruded semiconducting compound with a volume resistivity not in excess of 10 ohm-meters at 90C when tested per AEIC No. CS-6. The material shall be chemically and thermally compatible with the insulation.
- B. The extruded shield shall be clean stripping and shall have a peel strength from the insulation between 6 and 24 lbs./0.5 inch width when tested per AEIC No. CS-6. This compound shall have a minimum elongation after an air over test at 121C for 168 hours of 100% and a brittleness temperature not warmer than -50C.
- C. The thickness of the extruded shield shall be in accordance with the following:

Insulation Shield
Thickness (mils)

<u>Minimum Insulation Diameter (Inches)</u>	<u>Min. Point</u>	<u>Max. Point</u>
0 - 1.000	30	70
- 1.500	40	85
1.501 - 2.000	55	100
2.001 & Over	55	115

- D. The outer surface of the insulation shield shall be continuously printed with contrasting ink - "Semi conducting - Remove When Splicing or Terminating".

2.5. METALLIC SHIELD

- A. The extruded shield shall be covered with an uncoated copper tape. It shall be applied helically with a 12-1/2% minimum overlap.

2.6. JACKET

- A. The overall jacket shall be black PVC (polyvinylchloride).
B. The jacket thickness shall be as shown in Table III.

<u>TABLE III</u>	
<u>Cable Diameter Before Jacket (inches)</u>	<u>Jacket Thickness Minimum Average (mils)</u>
0 - 0.425	45
- 0.700	60
- 1.500	80
- 2.500	110
2.501 & larger	140

- C. The minimum thickness at any point shall be not less than 80% of the specified minimum average thickness.

2.7. IDENTIFICATION

- A. A permanent marker tape indicating "cable manufacturer, plant number, year of manufacture and sequential footage number" repeated each foot shall be inserted under the copper shielding tape.
- B. An identifying legend shall be printed on the jacket with contrasting ink repeated at two (2) foot intervals with unmarked surfaces not exceeding six inches. The legend shall provide the following information:
1. Manufacturer name and plant code
 2. Conductor Size - either AWG or kcmil
 3. CU
 4. Voltage
 5. Insulation Percent
 6. Insulation Thickness
 7. Insulation Type
 8. Footage at 2 ft. intervals

2.8. PRODUCTION TESTS

- A. Conductors shall meet the electrical resistance requirements of ICEA-68-516 Section 2.5.
- B. Insulation Resistance test shall be performed in accordance with the requirements of ICEA S-68-516, Part 6.28. Each cable shall have an insulation resistance not less than that corresponding to the insulation resistance constant of at least 50,000 megohms-1000 ft. at 15.6C.
- C. A high voltage ac and dc test shall be performed in accordance with Part 6.27 of ICEA S-68-516 at the ac and dc test voltages given in Table II.

- D. Shield resistance is measured and recorded from end to end on the completed cable.
- E. Corona Test: Each reel of completed shield power cable shall comply with the maximum partial discharge in picocoulombs specified in Table IV.

TABLE IV					
VT/vg ratio	1.0	1.5	2.5	3.0	4.0
AEIC CS-6 Reqmts (PacifiCorp)	5	5	5	5	10
Cable Voltage Rating in kV	Test Voltages (Vt) in kV Corresponding to Vt/Vg Ratio				
15	8.5	13.0	21.5	26.0	35.0

*The ac test voltages shown in Table II shall not be exceeded.

The partial discharges test shall be performed in accordance with the procedures of Section F of AEIC CS-6 and a X-Y recording graph will be furnished showing the corona test results.

2.9. QUALITY ASSURANCE

- A. The Cable shall be manufactured and tested under the control of a Quality Assurance program which meets the requirements of Section 10CFR50, Appendix B, of the Federal Register as defined in ANSI N45.2.
- B. The Quality Assurance program shall demonstrate compliance with the above referenced criteria by having passed yearly Quality Audits conducted by outside independent organizations.

PART 3 - MANUFACTURERS

3.1. ACCEPTABLE MANUFACTURERS

A. EPR

1. Okonite
2. BICC
3. Perelli
4. Kerite

END SECTION 16125

SECTION 16126 - POWER CABLE INSTALLATION METHODS

PART 1 - EXECUTION

1.1. GENERAL

- A. Install electric conductors and cables as indicated, in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standards of Installation", and in accordance with recognized industry practices.
- B. Primary cables shall not be pulled into concrete encased plastic conduit until all conduit joints made using plastic conduit cement have been allowed to dry for at least ½ hour.
- C. When pulling cables into conduit, the pulling line used shall have a safe working load rating (minimum) equal to the maximum allowable pulling line tensions for the type and size of cables being pulled as recommended by the manufacturer. Cables shall be pulled into conduit with a pulling eye attached to the cable conductor or a pulling grip placed over the cable sheath, insulation or jacket.
- D. When primary cables are pulled into straight conduit runs, the pulling line tension shall not exceed the values shown in the manufacturer's shop drawings.
- E. When primary cables are pulled into conduit runs including bends or sweeps, the maximum pulling line tension shall not exceed 300 times the radius of curvature of the bend or sweep with the smallest radius expressed in feet.

1.2. CABLES PULLING IN CONDUIT

- A. Whenever possible, pull cables so that bends in the conduit into which the cables are to be pulled are nearest to the feed-in end. This will result in minimum tension on the cables.
- B. On long pulls, the pull-out manhole should be rigged whenever possible, so that an adequate amount of cable for splicing and racking may be pulled into the manhole without the necessity of taking hitches on the cable sheath or jacket.
- C. In highly congested manholes or where cables must be bent sharply to permit pulling, use a feed-in tube for pulling in cables. This will reduce pulling tensions and prevent damage to the cables being pulled and to other adjacent cables.
- D. Before making a pull, conduits should be clear and free of dirt, rocks, etc.
- E. When pulling three or four single conductor cables in one conduit, consideration should be given to the possibility of the cables jamming, particularly at bends. This possibility occurs when the sum of the outside diameters of the three cables approximately equals the inside diameter of the conduit they are to be pulled into. When the possibility of jamming exists, pulling tension should be continuously monitored to ensure that damage to the cables, should they jam, will be kept to a minimum.
- F. Wire rope shall not be used to pull cables in nonmetallic conduits unless all bends in the conduits are constructed using a bent length of steel conduit or steel conduit elbows.
- G. Do not pull cable into duct or conduit until factory test reports of cable have been approved.
- H. Cables may be pulled by direct attachment to conductors or by use of basket weave pulling grip applied over cables. Attachment to pulling device shall be made through approved swivel connection. Cable may be pulled by using basket weave pulling grip, provided the pulling force does not exceed limits recommended by manufacturer; if pulling more than one cable, bind them together with friction tape before applying the grip. For long pulls requiring heavy pulling force, use pulling eyes attached to conductors.
- I. Do not exceed manufacturer's recommendations for maximum allowable pulling tension, side wall

pressure, and minimum allowable bending radius. In all cases, pulling tension applied to the conductors shall be limited to 0.008 lbs. per circular mil of conductor cross-section area.

- J. Pull in cable from the end having the sharpest bend; i.e. bend shall be closest to reel. Keep pulling tension to minimum by liberal use of lubricant, and turning of reel, and slack feeding of cable into duct entrance. Employ not less than one man at reel and one in pullhole during this operation.
- K. For training of cables, minimum bend radius to inner surface of cable shall be 15 times cable diameter.
- L. Where cable is pulled under tension over sheaves, conduit bends, or other curved surfaces, make minimum bend radius 50% greater than specified above for training.
- M. Use only wire and cable pulling compound recommended by the specific cable manufacturer, and which is listed by UL.
- N. Seal all cable ends unless splicing is to be done immediately.
- O. Train and support all cables in manholes, pullholes, concrete trenches, and similar locations by porcelain cable clamps. Place each cable on separate cable clamp.
- P. All cables shall have heat shrinkable caps (Raychem) installed until the cables are to be terminated. Caps shall prevent all water and moisture from entering the cables.

1.3. AFTER INSTALLATION TESTING

- A. After installation and before the operating test on connection to the existing system, the cable shall be given a high potential test.
- B. Test all cable per ICEA Standards and in accordance with IEEE Standard 400-1991. Notify Owner's representative of proposed date of test sufficiently in advance so that arrangements can be made for the Engineer and Southern Utah University personnel to witness the test.
- C. Direct-current voltage shall be applied on each phase conductor of the system by connecting conductors as one terminal and connecting grounds and metallic shieldings or sheaths of the cable as the other terminal for each test.
- D. For all new cable installation, perform test after all splices, terminations and connections are complete, except at point where cable under this contract is to be connected to existing system. Prior to making the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment.
- E. Test the conductor for continuity with all equipment disconnected.
- F. The method, voltage, length of time, shall be as specified and other characteristics of the test shall be in accordance with NEMA WC7 or WC8 for the particular type of cable installed, and shall not exceed the recommendations of IEEE Std. 48, 1990, for cable terminations unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing.
- G. High potential DC test for the new cable and equipment shall start at zero volts and increased in 5,000 volt increments until a maximum value of 35,000V is reached, for 15 kV systems. However, test voltage level shall not exceed manufacturers recommended test voltage for any cable, splices, or equipment connected to the system under test.
- H. The voltage step value as shown above shall be for a period of five minutes or until the leakage current has stabilized, whichever is less. If the leakage current does not stabilize, the test shall be stopped and the cable re-tested, if the second test does not stabilize, the cable test shall be discontinued.
- I. The leakage current shall be considered to be stabilized if the leakage current does not change more than five microamps in a 15 second period.

- J. Use DC tester specifically designed for the purpose, with overload or current-limiting devices to limit short circuit current. Record leakage current values at 1 minute intervals during the test. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed and perform a retest for acceptance.
- K. Submit three (3) copies of test, properly labeled, to the Engineer of review. Include all necessary test information such as cable system identification, ambient temperature, weather conditions, current, voltage, cable length, size, etc.

1.4. CABLE PHASING

- A. Each cable shall be properly "phased" to assure proper connection to the system.
- B. Supply all equipment needed to make phasing checks.
- C. Notify the Engineer and Southern Utah University sufficiently in advance of making phase checks to allow for arrangements to be made for the witnessing of the tests.
- D. Make necessary changes to cable connection points, as determined by phasing checks, and reverify phasing after any cable changes.

END SECTION 16126

SECTION 16127 - CABLE MARKING AND LOCATION

PART 1 - SCOPE

- 1.1. This specification details the standard method to be used for marking primary and secondary underground cables to indicate the general direction from which each cable extends from a given site.

It also details a method for identifying individual phases in multi-cable primary and secondary cable systems.

PART 2 - DEFINITIONS

2.1. PRIMARY CABLES

- A. All cables with voltage ratings greater than 600 volts.

2.2. SECONDARY CABLES

- A. All cables with voltage ratings of 600 volts or less.

PART 3 - INSTALLATION

3.1. DIRECTION IDENTIFICATION

- A. Primary and secondary cables shall be marked with tags with unique ID labels using equipment ID's as indicated in the drawings (i.e., vaults, primary junction boxes, service holes, manholes, secondary junction boxes, transformers, or splice boxes). This tag shall indicate the phase of the cable(s) and the ID of the next facilities where the cable is connected. All tags used must be approved by the Engineer.

1. All tags will be labeled with next point of connection. See attached instruction drawings.
2. All equipment will be numbered as per the instruction drawings prior to tagging the cable in order to be accurate. The tagging will be approved and inspected by the Engineer, and Southern Utah University personnel.

B. PHASE IDENTIFICATION (PRIMARY)

1. In addition to the cable tags, individual phases in a primary or secondary multi-cable installation are to be identified, bands of white tape shall be used. Each phase shall be identified as follows: one band of white for "A" Phase, two bands of white for "B" Phase, and three bands of white for "C" Phase. Where multiple bands are used, separate bands by one tape width.

C. TAPE INSTALLATION REQUIREMENTS

1. Width and Thickness

- (a) Tape used for phase identification shall be at least three layers of tape thick and should be limited in width to one width of tape.

2. Placement of Tapes on Cables

- (a) The tape used for phase identification shall be placed at a convenient and easily visible spot near the point of entrance and exit of cables from a given site. Care shall be taken when tape is placed on primary cables to ensure that the tape is placed over the conductor jacket.

D. CABLE IDENTIFICATION

1. Cable tagging will provide a means of identifying underground cables throughout their length. Specifically, this requirement includes the following:
 - (a) Cable phases should be tagged on all transformer equipment, meter equipment, cable switching stations, vault, and J-box locations.
 - (b) Care should be taken during the installation of the underground tagging system so that the cable phase identification integrity is maintained.
 - (c) The correct phase tag number should be placed on the cable whenever the cable is accessible such as in enclosures or splice boxes.
 - (d) Phasing should be indicated on the construction sketch so that this information can be placed on the permanent maps. This will include, but not be limited to:
 - (1) Phase identification of cables serving individual transformers.
 - (2) Phase identification of cables at all junction points.
 - (e) Cable tags must be changed whenever the cable system is changed.

E. SAFETY

1. **Do not shortcut or forget safe working procedures. Regardless of the accuracy of cable labeling, it cannot be relied upon when working and handling cables. The energized status of any individual cable must be tested by acceptable methods. Proper cable grounding procedures must be followed.**

END SECTION 16127

SECTION 16130 - TERMINATIONS AND SPLICES

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Conditions apply to this section.
- B. Section 16125 - Single Conductor Shielded Power Cable Rated 15 kV, Type MV-90 and PILC.
- C. Section 16126 - Power Cable Installation Methods

1.2. SUMMARY

- A. This Section includes terminations and splices for High Voltage cables, types of terminations and splices in this section include the following:
 - 1. Elbow Terminations.
 - (a) 600A Non-loadbreak

1.3. APPLICABLE STANDARDS

- A. IEEE 48-1990, Test procedures and the requirements for High-Voltage Cable Terminations.
- B. IEEE 404-1986, Standard for Cable Joints for use with Extruded Dielectric Cable Rated 5000 through 46,000 volts, and Cable Joints for use with laminated dielectric cable rated 2500 through 500,000 volts.
- C. AEIC-CS5
- D. AEIC-CS6
- E. AEIC-1-68
- F. ANSI/IEEE 386-1985

1.4. SUBMITTALS

- A. Product data for each type of termination and splice specified, to be used on the project.

PART 2 - PRODUCTS

2.1. GENERAL

- A. Terminations and splices shall be suitable for outdoor and vault installations.

2.2. ELBOW TERMINATIONS

- A. Electrical Specifications
 - 1. 600 AMP non-loadbreak premolded 15 kV elbow connectors. Voltage rating shall be 8.3 kV phase to ground/ 14.4 kV phase to phase.
 - (a) Impulse (BIL) 95 kV, 1.2 x 50 microsecond wave.
 - (b) AC withstand 34 kV, 60 HZ, 1 minute.
 - (c) Corona extinction level 11 kV.

2. All premolded rubber products shall be in accordance with ANSI/IEEE 386-1985
 - (a) All rubber molded products shall be 100% factory tested
 - (b) All rubber molded products shall be 100% peroxide cured, both insulation and semi conductive.
 - (c) All mating products shall be produced by the same manufacturer to insure compatibility.
3. All elbows shall be installed with proper shield adapting device.

PART 3 - EXECUTION

- 3.1. All materials for high voltage terminations and splices shall be provided by the Contractor. The Contractor shall not substitute materials or tapes without written approval of the cable and splice kit manufacturer.
- 3.2. Contractor will install all high voltage terminations and splices. The Contractor shall perform all racking and grounding of all cables and terminations.
- 3.3. Terminations and splices shall be compatible with the type and size of cable that they will be installed on.
- 3.4. Finished installations shall have basic impulse levels as required for the system voltage level.
- 3.5. Shields shall be applied as required to continue the shielding system through each entire cable joint. Shields may be integrally molded parts of preformed joints. Shields shall be grounded at each joint.
- 3.6. Contractor is responsible to supply all material for terminations and connections made to both existing and new equipment. Termination and connections must be suitable for the application and as noted in the drawings.

END OF SECTION 16130

SECTION 16145 - OUTDOOR PADMOUNT 15 kV PRIMARY METERING ENCLOSURE

PART 1 - GENERAL

1.1. SCOPE

- A. This specification is to provide technical guidelines for outdoor deadfront, padmount enclosed 15 kV primary metering enclosure. The metering enclosure will be installed outdoor adjacent to other high voltage switchgear and pedestrian walkways and shall be suitable for such an application.

1.2. SUBMITTALS

- A. The following types of Shop Drawings shall be submitted for the equipment specified within this section:
 - 1. Certificate of Compliance
 - 2. Detail Drawing
 - 3. Equipment Data (i.e. VT's, CT's, meter sockets, arresters, etc.)
 - 4. Fabrication/Erection Installation Drawings
 - 5. Manufacturer's Catalog Data
 - 6. Outline Drawings
 - 7. Single Line Drawings
 - 8. Test Reports

PART 2 - PRODUCTS

A. General

- 1. The metering enclosure shall be provided complete with the required voltage and current instrument transformers, meter socket, test switch, arresters, and associated high voltage busing and low voltage wiring for the meter.
- 2. The enclosure shall be rated 15 kV, 600 amp, 95 kV BIL. The primary system voltage will be 12.47Y/7.2 kV (grounded wye).
- 3. The metering enclosure shall have one (1) source set of bushings and two (2) sets of load bushings.
- 4. All components used shall be of new manufacture.
- 5. The metering assembly shall be enclosed in an outdoor padmount, dead front style enclosure, with vents for circulation of air, and heater for condensation prevention (if required). Any needed louvers shall be of the screened tamper proof type.
- 6. The enclosure shall house three voltage transformers, three current transformers, arresters, and will utilize a three stator, Form 9 meter.
- 7. Busing shall be silver plated copper, rated 600A continuous.

B. Instrument Transformers

1. Voltage Transformers

- (a) Dry type voltage transformers shall be used, suitable for outdoor use.
- (b) Voltage transformers shall conform to IEEE C57.13, Requirements for Instrument Transformers.
- (c) Voltage transformers shall be a utility grade. Primary terminations shall be of the solderless type.
- (d) Voltage Rating 7200V:120V; 110 kV BIL (single or dual bushing).
- (e) Accuracy Class: ANSI 0.3; Burdens W, X, M, Y, Z.
- (f) Secondary terminations shall be screw terminals.
- (g) Ratios shall be: 60:1.
- (h) Thermal rating shall be 1500 VA.
- (i) Secondary termination box shall be suitable for outdoor installation and shall have 1" conduit threaded hubs.
- (j) VT's shall be capable of being mounted in any position.
- (k) Manufacture:

- (1) GE Type JVW-5.
- (2) Associated Engineering PTT-110-8212.
- (3) Approved equal.
- (l) VT's shall have primary fuses.

2. Current Transformers

- (a) Dry type dual ratio current transformers shall be used, suitable for outdoor use.
- (b) Current transformers shall conform to IEEE C57.13, Requirements for Instrument Transformers.
- (c) Current transformer shall be a utility grade bar type transformer. Primary bar connections shall be suitable for use with standard 2 and /or 4 hole pads.
- (d) Voltage Rating 15 kV; 110 kV BIL.
- (e) Accuracy Class: ANSI 0.3; for Burdens B-0.1, B-0.2, B-0.5, B-1, and B-2.
- (f) Current transformers shall have a continuous thermal current factor of 2.0 for 300:5 ratio and 1.5 for 600:5 ratio.
- (g) Secondary terminations shall be screw terminals with an integral shorting bar.
- (h) Ratios shall be 300/600:5.
- (i) Secondary termination box shall be suitable for outdoor installation and shall have 1" conduit threaded hubs.
- (j) CT's shall be capable of being mounted in any position.
- (k) Manufacture:

- (1) GE Type JKW-5.
- (2) Associated Engineering BB-15-829.
- (3) Approved equal.

3. Wiring Requirements

- (a) CT and VT circuits shall be grounded at one location only.
- (b) CT circuits shall use #10 AWG wire. VT circuits shall use #12 AWG wire.
- (c) Secondary conductors shall be connected to the test switch as required.

C. Meter Socket

- 1. Provide a weather proof meter socket (13 terminal) with provisions for test switch mounting. The meter socket shall be mounted on the side of the metering enclosure.
- 2. A standard test switch shall be provided. Test switch shall allow for complete meter testing without requiring a primary outage. Provisions for measuring secondary current with the meter in service shall be provided.
- 3. The meter will be provided by Contractor; see drawings.

D. Cable Connections

- 1. Bushings shall be 600A non-loadbreak apparatus bushings rated at 40 kA asymmetrical, 25 kA symmetrical short time current, 110 kV BIL, and conform to ANSI/IEEE Standard 386.
- 2. Bushings are to be mounted in-line and located at a minimum height of 24 inches above the pad.
- 3. All bushings shall include bushing inserts of the appropriate size, type, and rating.
- 4. Bushings or bushing wells shall be supplied in accordance with the latest test and design values of IEEE, ANSI, NEMA, and the National Electrical Code (NEC).

E. Enclosure

- 1. The enclosure shall be rated for outdoor installation and shall be constructed in accordance with the latest applicable industry standards and governing local/national electrical code requirements. The manufacturer of the enclosure shall be the final assembler. Certified test reports per ANSI/IEEE standard 18-1980 shall be provided for this or other 15 kV padmount three phase metering enclosures. The enclosure shall be constructed of not less than twelve U.S. gauge 304L stainless steel and shall be of all welded construction with all roof, door, and cabinet corners welded and ground smooth. Bolting and after-welding are not acceptable. The enclosure roof shall be cross-kinked to allow for water shed

and additional strength.

- (a) Additionally, provide a "C" channel base below the frame for strength and connection to anchor bolts.
- (b) The enclosure, with the doors closed, shall be of the "flush door" design. Extended door mills which can trap water or debris will not be acceptable.
- (c) The enclosure shall have stainless steel (304L) door retainers to provide for the doors to be held in the 90, 110 and 140 degree open position.
- (d) The deadfront shall be constructed of a minimum twelve (12) U.S. gauge galvanized steel or stainless steel. The deadfront shall meet and be welded to the inside of the roof to provide additional support and a complete barrier between the elbow and component compartment(s).
- (e) The enclosure shall be provided with stainless steel (304L) ground pads with stainless steel (304L) ½"-15 UNC, 7/15" deep threaded nuts welded to the ground pads. The ground pads shall be welded to the enclosure walls and shall be free of paint.
- (f) Units have double doors on the dead front side of the enclosure as well as the back or live front side of the enclosure. The live front side is also furnished with a tamper resistant non-metallic inner barrier.
- (g) Door hinges shall be welded to door and to the enclosure in a configuration to allow removal of the doors in the open position. Hinge body and pin shall be stainless steel (304L) with a pin diameter of not less than 0.343".
- (h) Three point latching (top, bottom and center) shall be provided on enclosure doors. The hinges shall not be considered a latching point. The latching mechanism shall meet or exceed the latest revision of ANSI Standard 087.12.28-1988 and the original American Underground Committee Guide 2.13, Security for Pad-Mount Equipment. All latching hardware, including pentahead bolts, door rods and fasteners shall be stainless steel (304L). "DELTRIN AF" rollers on the top and bottom of door latch rods shall be provided to allow ease of operation and additional inner pressure to allow a tight seal when the doors are closed and latched.
- (i) All hardware for installing components, bus bar, enclosure panels, etc. shall be stainless steel (304L). All hardware for electrical connections to a bushing/bushing well shall be bronze hardware.
- (j) Lifting provisions shall be provided. Blind, threaded holes shall be permanently welded to the enclosure side walls to provide for lifting plate attachment.
- (k) Enclosure shall be marked and labeled in accordance with IEEE/NEMA standards. Labels identifying component compartments shall be affixed to the exterior of the enclosure and shall be clearly visible with the doors in the open or closed position.
- (l) A permanently stamped, non-corrosive nameplate shall be affixed to the enclosure indicating the nominal system voltage, maximum design voltage, basic insulation level, continuous current rating, CT ratio, VT ratio, and date of manufacture. Nameplate shall meet all applicable IEEE, ANSI, and NEMA standards and requirements.
- (m) Mimic bus and compartment labels shall be provided.
- (n) Paint coatings shall meet or exceed ANSI 057.12.28-1988 for enclosure coatings with certified life extension to 2,000 hours. Certified test reports shall be provided with quote. Finish coat shall be applied over a rust inhibiting primer to a minimum dry build of 3 to 4 mils. Finish coat color shall be Desert Tan (Munsell 10YR 6.0/3.0).
- (o) Source and load bushings shall be clearly labeled.
- (p) The enclosure shall be supplied with stainless steel (304L) parking stands welded to the equipment wall in accordance with the requirements of the system.
- (q) Phase, end, and compartment barriers shall be provided, where required, to allow proper phase to phase and phase to ground insulation for safe operation at the rated voltages. Minimum barrier thickness to be not less than 0.187 inches. All barrier material to be NEMA type GPO-3 glass reinforced polyester. Compartment barrier shall be installed in a hanging fashion for easy and rapid access in to the component compartment(s). Compartment barriers shall be equipped with nonconductive handles for ease of handling during installation and removal.

PART 3 - EXECUTION

- 3.1. Metering enclosure shall be installed as indicated in the drawings.

- 3.2. Install metering enclosures per manufacturer's written instructions and recognized industry practices.
- 3.3. Enclosure shall be plumb and level.
- 3.4. Terminate cables to positions as indicated on the drawings. Terminations must be of a type recommended by the manufacturer, and as specified.
- 3.5. Enclosures shall be properly grounded.
- 3.6. Install cable terminations to the metering enclosures as required in Section 16130.
- 3.7. Verify enclosure size and location with certified drawings and adjacent equipment for proper clearances. The Engineer shall be notified of any changes needed from those shown in the drawings.

END SECTION 16145

SECTION 16150 - GROUNDING

PART 1 - SCOPE

1.1. WORK INCLUDED

- A. This section covers the work related to the complete installation of the distribution grounding system. Grounding shall include a complete system for all switches metering equipment, transformer installations, manholes, and other appropriate equipment.

PART 2 - MATERIALS

2.1. GENERAL

- A. The Contractor shall furnish all ground materials also all other incidental items not specifically listed on the drawings, but required to make the grounding system complete. The Contractor shall provide all labor, tools, and equipment necessary for installation of the grounding system as shown on the drawings and specified herein.

2.2. GROUND RODS

- A. 5/8" by 10 foot copper clad steel ground rod.

2.3. GROUND CONDUCTORS

- A. Copper, #1/0 minimum, or as noted in the drawings.

2.4. GROUND CONNECTIONS

- A. Provide compression connectors (Amp "Wrench Lock" or equal) as required. Must meet IEEE Standard 837-1984.

PART 3 - WORKMANSHIP

3.1. GENERAL

- A. Except where specifically indicated otherwise, ground all exposed non-current-carrying metallic parts of electrical equipment, raceway systems, and the neutral of all wiring systems in strict accordance with the NEC, state, and other applicable laws and regulations.
- B. Grounding conductors shall be straight and free from kinks, breaks, and other damage after installation. Conductors shall be thoroughly cleaned prior to making connections.
- C. All intersections of ground cables shall be connected together. All taps and ground rods shall be connected with separate connectors.
- D. All junctions and splices shall be made at ground rods wherever reasonably possible.
- E. All equipment and all steel structures shall be connected to the ground system. This also includes all panels, junction boxes, and auxiliary equipment.
- F. Each major equipment item shall have at least two ground connections.
- G. All metal structures shall be bonded to the ground loop or grounding conductor of a given location.
- H. Connections of conductor to the equipment shall be made with two-hole bolt-on bar lugs, unless otherwise

specified, and connected in accordance with the manufacturer's recommendations.

3.2. NEUTRAL GROUNDING

- A. Neutral conductors shall be grounded at each equipment location and where indicated. Ground wires shall be not less than No. 1/0 AWG, except that where the rated phase current exceeds 400 amperes, the size of neutral ground wires shall be increased to not less than one-half the size of the cross-sectional area of the individual phase conductors. Where concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground wire and the opening shall be sealed with a suitable compound after installation of the ground wire. Bends greater than 45 degrees in ground wire connections to the ground rods or counterpoises are not permitted.

3.3. EQUIPMENT GROUNDING

- A. Equipment frames of metal-enclosed equipment, medium-voltage cable shields at cable terminations, and other non-current-carrying metal items, shall be grounded unless otherwise indicated. Connections to earth shall be made in the same manner as required for neutral grounding. Equipment or devices operating at less than 750 volts may be connected to secondary neutral grounds. Equipment operating at more than 750 volts to ground shall be provided with grounds separate from secondary neutral grounds, but both grounds shall be bonded together below grade at the ground rods or may utilize a common counterpoise. It should be noted that RGC secondary service conduits (where RGC is used for the full length of the conduit run(s)) are to be grounded at the service entrance end only).

3.4. GROUND RODS

- A. At each equipment location and as indicated in the drawings, a 5/8-inch by 10-foot copper-clad steel ground rod(s) (as indicated) shall be driven into the earth. Where applicable, ground rods shall be installed through the PVC sleeves approximately 4 inches (6 inches max) of the ground rod will extend above the concrete surface.

3.5. GENERAL REQUIREMENTS

- A. A resistance of not greater than 25 ohms shall be provided, unless otherwise specified.

3.6. OPERATING TEST

- A. After the installation is completed, the Contractor shall conduct an operating test for approval. Equipment shall be demonstrated to operate in accordance with the requirements herein. Tests shall be performed in the presence of the Engineer and Owner's Representative. The Contractor shall furnish instruments and personnel required for the test.

3.7. GROUND-RESISTANCE MEASUREMENTS

- A. Ground-resistance measurements of each ground rod shall be taken and certified by the Contractor to the Engineer. No part of the electrical distribution system shall be energized prior to the resistance testing of that system's ground rods and grounding system and submission of test results to the Engineer. Test reports shall indicate the location of the ground rod and grounding system and the resistance and the soil conditions at the time the test was performed. When the building water service is used as a ground or part of the grounding system, ground-resistance measurements shall also be made of this connection. Ground-resistance measurements shall be made in normally dry weather, not less than 24 hours after rainfall, and with the ground undertest isolated from other grounds. The resistance to ground shall be measured using the fall-of-potential method described in IEEE No. 142. If the resistance proves inadequate, then additional ground rods will be installed until an acceptable resistance level is achieved, up to a maximum of 4 ground rods for a given manhole, transformer enclosure or piece of equipment.
- B. Errors in the installation of the ground system shall be corrected by the Contractor at no expense to the Owner as directed by the Engineer.

3.8. EXECUTION

- A. Install a continuous copper ground conductor at each equipment location. Install ground rods as indicated, and connect to the ground conductor with #1/0 minimum bare copper conductor for major equipment as indicated in the drawings.
- B. Bond all metal structures (devices, equipment housings, etc.) to the ground loop with #6 bare copper conductor.
- C. At each location where the concentric neutral is exposed, bond the neutral conductor to the ground equipment grounding system.

(NOTE: The equipment ground conductors shall not be used as part of the cable neutrals.)

- D. The grounding at each location shall meet all current applicable codes. This applies to both existing and new locations.

END SECTION 16150

SECTION 16235 - ELECTRICAL BOXES AND FITTINGS

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. This is a Division-16 Basic Materials and Methods section and is part of each Division-16 Section referencing to electrical boxes and fittings specified in this section. See Raceway Section 16110 for additional requirements.

1.2. SUMMARY

- A. This section includes boxes and fittings for electrical installations and certain types of electrical fittings not covered in other sections. Types of products specified in this Section include:
 - 1. Pull and junction boxes.
 - 2. Bushings, locknuts and knockout closures.
 - 3. Conduit bodies.

1.3. SUBMITTALS - None required.

1.4. QUALITY ASSURANCE

- A. Electrical boxes, fittings, etc. shall comply with current applicable NEMA, ANSI and NEC requirements pertaining to material, construction, sizing, installation, testing and performance. All products shall be UL listed and labeled.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide floor boxes by the following:
 - 1. Crouse Hinds Co.
 - 2. Hubbell, Inc.
 - 3. Square D
 - 4. Steel City

2.2. CABINETS, BOXES, AND FITTINGS, GENERAL

- A. Electrical Boxes, and Fittings: Of required types, sizes, and NEMA enclosure classes. Provide units of types, sizes, and classes appropriate for the use and location. Provide all items complete with covers and accessories required for the intended use. Provide gaskets for units in damp or wet locations.

2.3. MATERIALS AND FINISHES

- A. Sheet Steel: Flat-rolled, code-gage, galvanized steel.
- B. Fasteners for General Use: Corrosion resistant screws and hardware including cadmium and zinc plated items.
- C. Fasteners for Damp or Wet Locations: Stainless steel screws and hardware.
- D. Cast Metal for Boxes, Enclosures, and Covers; Copper-free aluminum except as otherwise specified.

- E. Use non-metallic boxes for non-metallic sheathed cable and non metallic raceways.
- F. Finish: Gray baked enamel for items exposed in finished locations except as otherwise indicated.
- G. Fittings for Boxes and Enclosures: Conform to UL 514B. Malleable iron or zinc plated steel for conduit hubs, bushings and box connectors.

2.4. PULL AND JUNCTION BOXES

- A. Comply with UL 50, "Electrical Cabinets and Boxes", for boxes over 100 cubic inches volume. Boxes shall have screwed on covers of material same as box and shall be of size, shape and NEMA rating to suit application. Boxes to be code-gage sheet steel with welded seams and stainless steel bolts, washers, screws and nuts.

PART 3 - EXECUTION

3.1. INSTALLATION OF ELECTRICAL BOXES AND FITTINGS

- A. Locations: Install items where indicated and where required to suit code requirements and installation conditions.
- B. Cap unused knockout holes where blanks have been removed and plug unused conduit hubs.
- C. Support and fasten items securely in accordance with Division 16 Section "Supporting Devices."
- D. Sizes shall be adequate to meet NEC volume requirements or as indicated; whichever is more stringent per the application.
- E. Remove sharp edges where they may come in contact with wiring or personnel.
- F. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- G. Support boxes independently of conduit.
- H. Use gang box where more than one device is mounted together. Do not use sectional box.
- I. Do not install boxes or conduit bodies in inaccessible areas, behind ducts or equipment, etc.
- J. Provide pull and junction boxes for telephone, signal, and other systems at least 50 percent larger than would be required by Article 370 of NEC, or as indicated. Locate boxes strategically and provide shapes to permit easy pulling of future wires or cables of types normal for such systems.

3.2. GROUNDING

- A. Electrically ground metallic boxes and enclosures. Where wiring to item includes a grounding conductor, provide a grounding terminal in the interior of the box or enclosure.

END OF SECTION 16235

SECTION 16422 - CAST-IN-PLACE CONCRETE

PART 1 - INTRODUCTION

1.1. SCOPE

- A. This specification covers the furnishing of all material, equipment, accessories, tools, services, transportation, labor, and supervision required for the supply and installation of cast in place concrete.

1.2. CONCRETE

- A. Unless otherwise indicated, concrete shall be normal weight (145 pcf) ready-mixed concrete, conforming to ASTM C94.

1.3. ITEMS INCLUDED

- A. This specification includes the following items:
 - 1. Concrete for foundations and structures
 - 2. Concrete for Slabs on grade
 - 3. Reinforcement
 - 4. Formwork
 - 5. Embedded Items, including Anchor Bolts

1.4. CERTIFICATION

- A. The concrete manufacturer shall certify that the concrete delivered conforms to the specification for Ready-Mixed Concrete ASTM C94, and furnish the certification specified in Par. 14 of ASTM C94.

PART 2 - CODES AND STANDARDS

2.1. The following codes and standards of the latest revision shall be considered as part of this specification:

- A. American Concrete Institute, ACI 318, Building Code Requirements for Reinforced Concrete
- B. ACI 301, Specifications for Structural Concrete for Buildings
- C. ACI 304, Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete
- D. ACI 305, Recommended Practice for Hot Weather Concreting
- E. ACI 306, Recommended Practice for Cold Weather Concreting
- F. ACI 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures
- G. ACI 347, Recommended Practice for Concrete Formwork
- H. American Society for Testing and Materials (ASTM), as noted.
- I. American Welding Society D12.1, Recommended Practices for Welding Reinforcing Steel, Metal Inserts, and Connections in Reinforced Concrete Construction.
- J. Concrete Reinforcing Steel Institute (CRSI), as noted.

PART 3 - MATERIALS

3.1. CEMENT

- A. Unless otherwise noted, all cement shall be Portland Cement conforming to ASTM C150, Type V cement. All cement supplied shall be of one manufacturer.

3.2. WATER

- A. Water used in mixing shall be clean and free from deleterious amounts of acids, alkalis, organic matter, or other impurities likely to be injurious to concrete.

3.3. ADMIXTURES

- A. Chemical Admixtures shall conform to "Chemical Admixtures for Concrete" (ASTM C 494) and shall not be used unless prior approval in writing is obtained from the Engineer. Where approved, the admixture shall maintain or improve the strength and/or durability of concrete of the original design mix. Admixtures shall be used in strict accordance with the manufacturer's recommendations and shall be accompanied by the services of the qualified field representative of the manufacturer to supervise the use thereof. A certificate from an approved laboratory attesting that the admixture equals or exceeds ASTM C494, Type D will be required.
- B. Air Entraining Admixtures shall conform to "Specifications for Air-Entraining Admixtures for Concrete" (ASTM C 260). Air content shall be determined in accordance with ASTM C231. The agent and the cement proposed for use shall be selected well in advance of concrete placing. Approved air-entraining admixtures are as follows:
 - 1. Darex AEA (Grace Construction Materials)
 - 2. MB-VR (Master Builders Co.)
 - 3. Sika AER (Sika Chemical Corp.)
- C. The use of accelerators shall not be allowed.
- D. Calcium chloride shall not be used as an admixture.

3.4. AGGREGATE

- A. Fine aggregate shall conform to "Concrete Aggregates" (ASTM C33), except for gradation which shall be as follows:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8 inch	100
No. 4	95-100
No. 16	65-95
No. 50	7-30
No.100	No More Than 7 %

- B. Coarse aggregate shall conform to "Concrete Aggregates" (ASTM C33) One inch to No. 4 size.
- C. Aggregates for type V cement shall be sharp acid-resistant type silica rocks. Quartz, flintstone, etc. are preferred. Absolutely no carbonate rocks such as limestone, calcite, dolomite, magnetite, siderite, etc. shall be used.

3.5. CONCRETE DURABILITY AND QUALITY

- A. All concrete shall meet the durability and quality requirements specified in ACI 318, Chapters 4 and 5.
- B. The 28 day compressive strength, f'_c , of the concrete shall be not less than 4000 psi or as specified on the drawings.
- C. Method of proportioning shall be in accordance with ACI 211.1, "Recommended Practice for Selecting

Proportions for Normal and Heavy Weight Concrete."

- D. The determination of the water-cement ratio to attain the required strength shall be in accordance with ACI 301, Method 2 (For combinations of materials previously evaluated or to be established by trial mixes), and with ACI 211.1. In addition, the maximum water-cement ratio (by weight) shall be 0.45 and the minimum cement content shall be 5-1/2 sacks per cubic yard.
- E. From the test results of the aforementioned procedures, a curve shall be plotted showing relationship between the water-cement ratio and compressive strength, and the maximum water-cement ratio to be used shall be the value shown by the curve to produce the strength a minimum of 25 percent greater than the strength specified.
- F. The concrete mix design shall be submitted to the Engineer for approval prior to beginning of any concrete work.
- G. Maximum aggregate size shall meet the requirements of ACI 318, Section 3.3.
- H. Unless otherwise noted or approved, all concrete shall be air-entrained. Air entrainment shall be accomplished through the use of an approved admixture.
- I. Air Content
 - 1. The air content shall be as follows:
 - (a) 6 to 10 percent for 3/8 inch maximum aggregate size
 - (b) 5 to 9 percent for 1/2 inch maximum aggregate size.
 - (c) 4 to 8 percent for 3/4 inch maximum aggregate size.
 - (d) 3.5 to 6.5 percent for 1 inch maximum aggregate size.
 - (e) 3 to 6 percent for 1-1/2 inch maximum aggregate size.
 - (f) 2.5 to 5.5 percent for 2 inch maximum aggregate size.

J. Slump

<u>Types of Construction:</u>	<u>Slump in Inches</u>	
	<u>Maximum</u>	<u>Minimum</u>
Reinforced foundation walls, footings, and small mat foundations	4	2
Reinforced slabs, beams and walls	4	2
Equipment foundations	5	3
Sidewalks, driveways, and slabs on ground	4	2

- K. Mixing, transporting and placing concrete shall conform to applicable portions of ACI 211, ACI 212 and ACI 304 and as specified herein.

3.6. REINFORCEMENT

A. Deformed Bars

- 1. Deformed reinforcing steel bars shall conform to ASTM A615, Grade 60 unless noted otherwise. Bars shall be tagged with mark number and size before shipment.

B. Coated Bars

- 1. If specified by the drawings, reinforcing bars shall be either galvanized or epoxy coated.
- 2. Galvanized coated reinforcement shall be Class I hot dipped after fabrication zinc coated in accordance with ASTM 767. If the galvanized surface is damaged prior to placement of concrete, it shall be repaired in accordance with ASTM A780.
- 3. Epoxy coated reinforcement shall be epoxy coated in accordance with ASTM A775. If the epoxy

surface is damaged prior to placement of concrete, it shall be repaired with "3M Scottcoat 306" in accordance with manufacturer's specifications.

C. Welded Wire Fabric

1. Welded Wire Fabric shall conform to "Welded Steel Wire Fabric for Concrete Reinforcement" ASTM A185.

D. Steel Wire

1. All cold-drawn steel wire for concrete reinforcement shall be in accordance with ASTM A 82.

E. Synthetic Fiber Secondary Reinforcement

1. Synthetic reinforcing fibers shall be collated fibrillated polypropylene, as manufactured by Fibermesh, Inc. or equal.

F. Accessories

1. Accessories shall conform to CRSI Manual of Standard Practice of Reinforced Concrete Construction. Include all devices necessary for proper placing, spacing, supporting, and fastening steel reinforcement in place. Accessories shall be galvanized after fabrication if underside of concrete will be exposed.

G. Concrete Squares (Precast Reinforcing Chairs)

1. Squares shall be approximately two inches square and of a thickness adequate to provide the cover for the reinforcing steel as called for on the plans. The squares shall be made using a mixture of one part Portland Cement to three parts sand (fine aggregate) and the tie wires shall be cast integrally with each square.

3.7. FORM WORK

A. Design

1. Formwork shall be designed for loads and lateral pressures outlined in Chapter 1, Recommended Practice for Concrete Formwork (ACI 347) and wind loads as specified by the controlling local building code. Formwork design and construction are the responsibility of the Contractor.

B. Forms

1. Forms shall be constructed of wood, steel, or other approved material. Material shall be chosen based on strength and concrete finish requirements.

3.8. EMBEDDED ITEMS

A. Anchor Bolts and Sleeves

1. Unless noted otherwise, anchor bolts shall conform to ASTM A36 Steel as shown on the drawing. Sleeves, if required shall be of high impact plastic or schedule 40 steel pipe with sleeve bottom closures of mild steel. Furnish each bolt with one heavy hex nut and washer unless otherwise noted on the drawing.

B. Embedded Metals

1. Curb angles, frames, beams, ducts, etc., shall be fabricated of ASTM A-36 material, and in accordance with Specification for Division 5, "Structural and Miscellaneous Steel".

C. Waterstops

1. Unless otherwise noted on the drawings, waterstops shall be of the dumbbell or centerbulb type made from either rubber, neoprene or PVC. Type and material of waterstop shall be approved by the Engineer before installation.

D. Expansion Joint Filler

1. Filler shall be ½" thick and shall meet the requirements of ASTM D 1751 for bituminous type or ASTM D 1752 or ASTM D 2628 for nonbituminous type. Where required or shown on the drawings a non-impregnated compressible foam backer rod shall be installed in the expansion joint prior to applying joint sealer. The backer rod shall be 1/8 inch larger in diameter than the joint width and shall be placed in the joint so as to provide a clear depth above the backer rod from the finished concrete surface equal to ½ the joint width.

E. Joint Sealer

1. Unless otherwise noted, sealer shall conform to ASTM D 1190. Sealant used in expansion joints requiring backer rods shall be a non-priming urethane sealant conforming to ASTM C 920.

F. Subsurface Covering (Vapor Barrier)

1. Polyethylene sheeting 6 mil (0.006") thick natural clear conforming to commercial standard CS 238 or ASTM D 2103.

G. Felt Joints

1. 15 lb asphalt felt shall conform to ASTM D 250.

H. Fiber Board

1. Tempered hard board shall conform to commercial standard CS 251.

PART 4 - EXECUTION

4.1. PREPARATION

- A. In no case shall concrete be placed on muddy, spongy, or frozen subgrade.
- B. All wood scraps and debris shall be removed from the areas in which concrete is to be placed.
- C. All areas where concrete is to be placed shall be thoroughly cleaned to ensure proper placement and bonding.
- D. Forms and subgrade shall be wetted and all standing water removed prior to placing concrete.
- E. All transporting and handling equipment shall be thoroughly cleaned.

4.2. FORMWORK

A. Installation

1. Forms shall be constructed to the shape, line, and grade required and shall be maintained sufficiently rigid to prevent deformation under load, including placing and compacting of concrete. Set forms and screens for floor and decks to provide uniform slopes to drains and positive drainage for exterior slabs and steps. Forms shall be tight enough to prevent leakage of mortar. Formwork shall be secured to prevent sagging, yielding, bulging, depressions, waves, or other defects in the finished work. Forms shall be smooth and free from warp. Temporary openings shall be provided at base of column and wall forms for cleaning and inspection. All debris including mud shall be removed before placing concrete. Use of patented prefabricated panel sections for forming straight wall sections shall receive

prior approval of type and procedure including type of ties to be used. Lumber once used shall be carefully cleaned and oiled before reuse.

B. Earth Sides

1. Earth sides may be utilized if clean cut and stable at time of concrete placing. Earth must be undisturbed or compacted to 95% density in accordance with ASTM D 1557, and free from surface water.

C. Chamfering

1. Exposed corners of concrete shall have 3/4" chamfers unless shown otherwise.

D. Form Treatment

1. Board Forms: Keep wet previous to placing concrete; wet thoroughly just before placing.
2. Plywood Forms: For surfaces to be painted use silicone-type bondbreaker, Burke, West Chemical or approved equal, applied in accordance with manufacturer's directions. Coat other surfaces with approved stainless form oil, using minimum quantity required for satisfactory removal.
3. Metal Forms: Approved-type release compound, applied in accordance with manufacturer's directions.

E. Form Removal

1. Side forms of walls and beams can be removed after 1 to 3 days. Load-supporting forms and shoring shall not be removed until after 7 days or two-thirds of designed 28 day compressive strength is obtained or the 7-day test cylinders have been tested and results indicate an average strength adequate to support the load imposed on the concrete. All forms shall be completely removed after setting of concrete together with all temporary supports, etc., employed for construction purposes. Forms shall be readily removable without hammering or prying against the concrete. Days having temperatures below 40EF are not to be counted for form removal unless thermal protection for the concrete has been provided.

4.3. REINFORCEMENT

A. Detailing and Fabrication

1. Reinforcing steel shall be detailed and fabricated in accordance with ACI 315.
2. The fabricating contractor shall prepare complete placing drawings and bending schedules. All drawings, thus produced, shall be submitted to the Engineer for approval. No fabrication of reinforcing steel shall be done until drawings have been approved.

B. Splicing

1. Bar splices shall be made in accordance with ACI 318 Chapter 12 unless noted otherwise on the design drawings. Any deviation will require approval of the Engineer.
2. When welded splices are specified on the design drawings, the welding shall conform to AWS D12.1. Unless specified, welding of reinforcement is prohibited.
3. Splices in welded wire fabric shall be made by lapping a minimum of one spacing of outermost cross wires of each fabric sheet plus two inches.

C. Installation

1. Before being placed, reinforcing shall be free from loose flaky rust, oil, grease, mud, or other coating, including ice that would reduce or destroy the bond. Reinforcement shall be accurately placed and properly secured in position by precast concrete squares, metal chairs or spacers. The use of heat to bend or straighten reinforcing will be permitted only if the entire operation is approved by the Engineer. Tolerances, spacing, splices, and concrete protection to conform with Chapter 7 and 12 of the ACI 318 Building Code.

D. Ties

1. With the exception of temperature reinforcement, which shall be tied to main steel, reinforcement shall be accurately placed and securely tied at all intersections and splices with 18 gauge black annealed wire, and shall be securely held in position during the placing of concrete by spacers, chairs, squares, or other approved supports. Wire tie ends shall point away from the form. Unless otherwise indicated, the number, type, and spacing of supports shall conform to ACI 315 Manual.

E. Stirrups

1. All stirrups, except ties, shall be held in place by two spacer bars extending the full length of the beam or girder.

F. Mesh

1. Reinforcing mesh shall be installed by one of the following methods to obtain the spacing indicated on the drawings:
 - (a) Deposit a layer of concrete and strike off at the level required for the indicated spacing. Lay the mesh on the struck-off surface, place reinforcing bars, if required, and then continue pouring to full slab thickness. Use this method only when position of mesh is critical, as specified on the drawings or as directed by the Engineer.
 - (b) Place mesh on preformed concrete blocks wired to the mesh, pour concrete, and adjust mesh as required. This is the preferred method when exact positioning is not specified as critical.

G. Slabs on Grade

1. Reinforcing for re-entrant corners and perimeter steel around the edge of each pouring unit shall be ½" diameter (#4) deformed bars. Bars used as dowels in joints shall be ½" diameter plain round bars 2' long and spaced on 24" centers, unless otherwise indicated on detailed drawings.

H. Watertight Construction

1. Standard accessory items (i.e. chairs, etc.) shall not be used in the construction of tanks, reservoirs, basins or other structures to contain water, waste water, or sewage. All reinforcing steel in the walls, beams, columns and slabs of such structures shall be supported on and held away from the forms by using precast concrete "squares" so that no metal is exposed on the face of the concrete when the forms are stripped.

I. Synthetic Fiber Secondary Reinforcement

1. Synthetic fibrous reinforcement: Collated, fibrillated polypropylene with a mix ratio of 1.5 pounds of fiber to 1.0 cubic yards of concrete is to be used in all concrete used for curb, gutter, sidewalk and all other exterior flatwork.

4.4. EMBEDDED ITEMS

- A. No pours are to be made until all embedded items, anchor bolts, electrical conduits, steel frames, pipe supports, etc., are properly positioned and secured and required inspections of same completed. The contractor shall be responsible for and coordinated with other trades to obtain necessary data and information.

- B. All sleeves, inserts, anchor bolts, waterstops, and other embedded items shall be positioned accurately and supported against displacement.

C. Anchor Bolts

1. Fabrication: Anchor bolts shall be complete with flat plate bolt washer, semi-finished hexagon nut and, if required, anchor bolt sleeve. Anchor bolt threads shall be N.C. Class 1 fit. Welding shall be in

- accordance with AWS recommended practice.
2. Installation: Anchor bolts shall be set true to the lines and grades shown on the drawings and shall be set plumb and be securely braced to prevent displacement during placing of concrete. Threads shall be protected by coating with oil or grease and encasing them in burlap or paper. Upon completion of concrete placement, bolts shall be rechecked for correct location and elevations. Should any bolt exceed acceptable tolerances such corrections as are necessary shall be made at no additional cost.
 3. Anchor Tolerances: Tolerance limits in setting of anchors and anchor bolts shall be as follows:
 - (a) Location, sleeved: 3/16 inch
 - (b) Location, unsleeved: 1/8 inch
 - (c) Projection: plus 1/4 inch, minus 0 inch

D. Embedded Metals

1. Fabrication

- (a) Curb angles, frames, beams, etc., shall have suitable anchors securely welded on centers not exceeding two feet. Anchors shall also be positioned within 6 inches of ends and corners. All joints, corners, splices, etc. shall be seal welded and the exposed surfaces ground flush. All metal surfaces shall be free from scale, rust, oil, grease or other contaminants and those not intended for contact with the concrete shall be coated with zinc chromate primer, unless otherwise specified on the drawings or by the Engineer.
- (b) The fabricated length of pipe sleeves shall be equal to the thickness of concrete they penetrate. Ends of pipe sleeves shall be cut square and flush with the face of concrete. Unless otherwise specified or shown on the Drawings, pipe sleeves shall be secured against movement by welding a ring or flange around the outside midpoint of the sleeve.
- (c) Ducts shall be fabricated as shown on the Drawings.

2. Installation

- (a) All embedded curb angles, beams, frames, pipe sleeves, etc. shall be set true to the lines and grades shown on the drawings. Embedded items shall be secured and braced to prevent shifting during concrete placing. Where dissimilar metals are to be embedded in direct contact with one another, the contacting surfaces shall be heavily coated with bituminous mastic or other Engineer-approved surface treatment to prevent galvanic coupling.

4.5. MIXING CONCRETE

- A. The mixer and mixing time shall be in accordance with ACI 304. Hot weather concreting shall comply with ACI 305, and cold weather concreting with ACI 306.
- B. No additional water shall be added to batched concrete without the permission of the Engineer. Such water shall be incorporated by additional mixing equal to at least half of the total mixing required for the batch. Any addition of water above that permitted by the limitation on specified water-cement ratio, shall be accompanied by a quantity of cement sufficient to maintain the proper water-cement ratio.
- C. Concrete shall be mixed only in such quantities as are required for immediate use. The maximum allowable time between charging of the material in the mixing drum and final placing for mean ambient temperatures below 90°F shall be ninety (90) minutes or 300 drum revolutions, whichever comes first. Concrete to be delivered when the mean ambient temperature exceeds 90°F shall be mixed and delivered in accordance with the requirements of ACI 305 "Recommended Practice for Hot-Weather Concreting". Concrete not placed within these time limits, or if an initial set has developed, shall not be used. Tempering concrete by adding water or by other means will not be permitted.
- D. Ready Mix Concrete: The Contractor is to provide a computerized ticket with each batch to be delivered to the project manager that includes the following information:
 1. Name of ready-mix batch plant.
 2. Serial number of ticket.

3. Date and number of truck.
4. Name of Contractor.
5. Specific designation of job (name and location).
6. Volume of concrete (number of cubic yards).
7. Time batch was dispensed to truck.
8. Ready of revolution counter at first addition of water.
9. Signature or initials of ready-mix representative.
10. Type and brand of cement.
11. Amount of cement (can be indicated by weight or quantity).
12. Total water content by producer (can be indicated by weight or quantity).
13. Water added by receiver of concrete and his initials (can be indicated by weight or quantity).
14. Admixtures and amount of same.
15. Maximum size of aggregate.
16. Weights of fine and coarse aggregates.
17. Indication that all ingredients are as previously certified or approved.

4.6. PLACING CONCRETE

- A. Concrete shall not be placed prior to a recorded pre-placement inspection and/or authorization to proceed by the Engineer. The Contractor must obtain the project manager's approval of all dimensions, steel location, condition of forms, and placing equipment at least four (4) working hours prior to placing any concrete.
- B. The slump may be increased up to 6 inches if concrete pumping is to be used. The proposed mix design for pumped concrete shall be approved by the Engineer.
- C. Conveying and placing of concrete shall be in accordance with ACI 304.
- D. Each day's pour shall be properly scheduled to assure that concrete surfaces can be finished correctly and the use of cold joints can be minimized.
- E. All concrete shall be mechanically vibrated, except for slabs on grade that are six inches or less in thickness.
- F. Concrete shall be placed in layers not over 24 inches deep. Each layer shall be consolidated by mechanical internal-vibrating equipment supplemented by hand spading, rodding, and tamping to work concrete into all angles and narrow places. Duration of vibration shall be limited to the time necessary to produce satisfactory consolidation without causing objectionable segregation. Vibrators shall be applied vertically and at uniformly spaced points not farther apart than the visible effectiveness of the machine. The vibrator shall not be inserted into lower courses that have begun to set. Vibrators shall not be used to transport concrete inside forms. The use of form vibrators or form tamping will not be permitted.
- G. The free fall of concrete from the end of the spout or chute, or from a transporting vehicle, shall not exceed 10 feet for thin walls (10 inches or less in thickness) nor more than 5 feet for other types of construction.
- H. A tremie or flexible metal spout shall be used when the distance through which concrete must be dropped vertically exceeds the maximum specified above. Flexible metal spouts shall be composed of conical sections not more than three feet long, with the diameter of the outlet and the taper of the various sections such that the concrete will fill the outlet and be retarded in its flow.
- I. Chutes, troughs, or pipes used as aids in placing concrete shall be arranged and used so that the ingredients of the concrete will not be separated. Chutes and troughs shall be of metal or metal-lined. When steep slopes are necessary, the chutes shall be equipped with baffle boards or a reversed section at the outlet. Open troughs and chutes shall extend, if necessary, down inside the form or through holes left in the forms; or the ends of such chutes shall terminate in vertical downspouts. All chutes, troughs, and pipes shall be kept clean and free from coatings or hardened mortar by a thorough flushing with water before and after each placement. Water used for flushing shall be discharged outside of the forms.
- J. The concrete shall be deposited, as nearly as possible, in its final position and shall not be caused to flow

laterally in the form for any considerable distance. Each pour shall be completed in a continuous operation with no interruptions in excess of forty-five minutes. Each layer shall be placed and compacted before the preceding layer has taken initial set.

- K. The placing sequence shall always be arranged to allow for the effects of settling and shrinkage. Walls 10'-0 and over in height shall be stopped about 1 foot short of the top and allowed to settle one hour minimum before topping out. Walls and columns bearing superimposed slabs or beams shall be allowed to settle a minimum of two hours before pouring slabs or beams. Laitance shall be removed before pouring superimposed structural members.

4.7. BONDING

- A. The existing surfaces shall be thoroughly cleaned of all foreign material and laitance before depositing new concrete on old concrete or against concrete which has set. Existing surfaces shall be coated with a bonding agent in accordance with specification for Section 03315, "Bonding and Grouting".

4.8. JOINTS

- A. Construction and control joints shall be placed as indicated on drawings (when shown).
- B. Use of construction and control joints, when not shown on the drawings, shall be in accordance with ACI 318, Chapter 6.4, and subject to approval of the Engineer.
- C. Waterstops shall be installed as shown on the drawings, forming a continuous diaphragm in each joint. Support for waterstops shall be provided and waterstop material shall be protected from damage. Field joints in waterstops shall be fabricated in accordance with manufacturer's instructions.
- D. Saw cutting of contraction joints shall be done as soon as concrete hardens sufficiently (normally 4-12 hours) so as not to be torn or damaged by the blade. Sawing shall not be done while concrete temperature is falling. Construction and control joints shall be filled with an approved sealant, and premolded joint filler, and/or backer rod as shown on the drawings.
- E. Joints not specified on the design drawings shall be in accordance with ACI 301, Chapter 6, and Section 11.5.
- F. All reinforcing shall be continued across construction joints. Keys shall be provided only if required by the design drawings.
- G. When called for on the design drawings, the concrete surface at construction joints shall be roughened uniformly to approximately 1/4 inch, and laitance, loosened aggregate or damaged surface concrete shall be removed.
- H. Paving or slab construction joints, when not specified on the design drawings, shall be located at column centerlines and at intermediate intervals so that each panel shall be not more than 400 square feet in the area, unless slab is reinforced, in which case the area shall not be more than 600 square feet. Maximum spacing of construction joints in unreinforced slabs shall not exceed twice the slab thickness in inches (i.e., 6 inch slab: 12 feet) nor 1-1/2 times the width for narrow slabs such as sidewalks. Concrete shall be placed in checker board patterns or in alternate paving lanes utilizing construction and contraction joints to provide panels of the size shown on the drawing (when shown).

4.9. FINISHING CONCRETE

- A. Form ties shall be broken back 1 inch from the surface of the concrete. The remaining holes shall be filled by seal patching using a 1- to -2 mix of cement-sand mortar.
- B. All voids and honeycomb in formed concrete shall be filled with a 1- to -2 cement-sand mortar mix. Form ridges and other projections shall be removed immediately, after forms are removed. Exposed form concrete shall be rubbed with a carborundum brick and a thin cement grout shall be applied as necessary to produce a true, even, finished surface. Grout shall extend at least 3" below finished backfill grade on grade

walls.

- C. Concrete surfaces left low for grouting shall be roughened to expose aggregate, and all loose particles and laitance shall be removed. Anchor bolt threads shall be wire brushed, and greased, after concrete has set. Nuts and washers shall be placed on the bolts.

4.10. FINISH FOR FLOORS AND WALLS

- A. Interior building slabs including pit floors shall be screeded, floated, and steel troweled.
- B. Exterior slabs shall be screeded, floated, troweled, and broomed.
- C. Special care shall be exercised on floors that have drains or trenches. Floors shall be sloped uniformly to provide even fall for drainage.

4.11. SCREEDING, FLOATING, TROWELING, BROOMING & NONSLIP FINISHING

- A. Surfaces shall be screeded to the elevations shown on the drawings. "Con-Film" or Engineer-approved equal shall be sprayed on the screeded surface in conformity with manufacturer's directions if the air temperature is expected to reach 80°F or above before cure is complete.
- B. Floating shall start as soon as the screeded surface has stiffened sufficiently. Floating shall be performed as necessary to produce a smooth, even, textured finish. Floating shall be performed by hand using magnesium tools.
- C. The slab surface shall be tested for accuracy with a straight edge after the first floating finish is completed. Any depressions shall be filled and high areas shall be cut down and reworked. Straight edge testing and refloating shall continue until there are no deviations of more than 1/8 inch under a ten foot straight edge.
- D. Interior slabs shall be troweled except as noted on drawings or specified otherwise. Steel troweling shall begin after straight edge testing is finished and while concrete is still green, but sufficiently hardened to bear a person's weight without deep imprint. Steel troweling shall produce a smooth troweled finish per ACI Standard 301, Section 11.7.3 "Trowel Finish". Time lapse and number of trowelings to produce a hard surface will vary depending on weather conditions.
- E. Exterior slabs and other surfaces, as noted, shall be broomed after final floating to provide a nonskid surface. A soft bristled push broom shall be used, with a swirling motion.
- F. Surfaces indicated shall have a nonslip finish obtained by sprinkling not less than 1/4 pound of abrasive aggregate over each square foot of the screeded and floated concrete, and finishing immediately with a steel trowel. The abrasive aggregate shall consist of not less than 55 percent aluminum-oxide or silicon-carbide abrasive ceramically bonded together to form a homogeneous material that will be sufficiently porous to provide a good bond with Portland cement. The aggregate shall have an abrasive hardness of not less than 40 as determined by the test for wear resistance in the National Bureau of Standards Report BMS 98.

4.12. CURING AND SEALING

- A. All finished concrete shall be cured by a curing method compatible with the final floor finish for a minimum of 7 days in accordance with ACI 301 Chapter 12. One or more of the following methods may be used, if approved by the Engineer, except where a specified curing method is called for:
 - 1. Water curing by ponding or continuous wetting of sand or burlap.
 - 2. Form curing by leaving on the forms and wetting for seven days.
 - 3. An approved sprayed-on curing compound applied in accordance with the manufacturer's instruction.
 - 4. Steel troweled floor slabs, not covered with other materials shall receive two coats of "Cenco Seal 301" surface hardener applied after all other equipment and work in the building has been installed and/or completed and the floor has been thoroughly cleaned of all dust, dirt, masks, and foreign matter.

4.13. COLD WEATHER CONCRETING

- A. Thorough preparation for protection against cold weather damage to concrete shall be made well in advance. Cold weather concreting shall be performed in accordance with ACI 306.
- B. Concrete shall be protected from freezing for not less than the first 48 hours after placing after the first frost, or when the mean 24-hour temperature at the job site falls below 40EF.
- C. The placing temperature of the concrete shall be maintained above 50EF when the mean 24-hour temperature falls below 40EF.
- D. The temperature of fresh-placed concrete shall be between 50 and 60EF.

4.14. HOT WEATHER CONCRETING

- A. Thorough preparation for protection against hot weather damage to concrete shall be made well in advance. Hot weather concreting shall be performed in accordance with ACI 305.
- B. The maximum concrete temperature, at time of placement, shall be limited in accordance with ACI 305, Figure 2.1.5. The evaporation rate of the mixing water shall not exceed 0.2 pounds of water per square foot per hour.
- C. One or more of the ingredients may have to be cooled to keep the temperature of the concrete from being excessive at time of placement. The replacement of part of the mixing water with an equal weight of crushed ice is recommended for effective cooling per ACI 305, figure 2.3.6.
- D. In-place concrete shall be protected and cured so as to minimize drying and absorption of heat.

4.15. COLORED CONCRETE FOR UNDERGROUND DUCT ENVELOPE

- A. Materials and Proportioning
 - 1. All colored concrete shall have a specified compressive strength of 2,000 psi at 28 days. Maximum aggregate size shall be 3/8 inch.
 - 2. Concrete shall be mixed for at least ten minutes after color admixture has been added.
- B. Color Admixture
 - 1. All colored concrete for underground electrical conduit envelopes shall be colored RED. One pound of Red Oxide Color, C. K. Williams and Company, RD-3097, or authorized substitute, shall be used per sack of cement.

4.16. PUMPED CONCRETE

- A. The use of pumped concrete shall be approved in each case by the Engineer.
- B. The proposed mix design for each class of concrete to be pumped, including all necessary background data of test results, shall be submitted to the Engineer for approval.
- C. All slump and cylinder test samples shall be taken from the end of the discharge line.
- D. Cutting and patching on any portion of the work after it has been completed shall be done only with the approval of, and as instructed by the Engineer.
- E. Forms, equipment, protective coverings, and rubbish resulting therefrom shall be removed from the premises upon completion of the work.

PART 5 - TESTING AND INSPECTION

5.1. INSPECTION

- A. All forms, reinforcement, and anchor bolts shall be inspected and approved by the Owner's inspector before concrete is placed. If work is found unsatisfactory, the work shall not proceed until all defects have been remedied. Repaired work shall be approved by the Owner's inspector. Such approval will in no way relieve the contractor of his obligation to produce finished concrete as required by the drawings and specifications.

5.2. TESTING

- A. Testing and acceptance of tests of concrete shall be done in accordance with ASTM C31, C39, C94, C143, C172, and C173, D75 and C136.
- B. Provide details for testing and inspection schedule. Concrete testing shall be coordinated by the Campus Design and Construction's project manager and paid for by the owner. Additional testing due to test failure shall be specified to be at the Contractor's expense. Testing requirements should include:
 - 1. Slump: Test on each truck load.
 - 2. Air Entrainment: Test on every truck load.
 - 3. Temperature: Test on every truck load.
 - 4. Strength: Three cylinder every 50 cubic yards ([1] 7 day and [2] 28 day).
- C. The Contractor shall supply concrete for all tests.
- D. Concrete shall be sampled, cured, tested and accepted for compressive strength in accordance with ASTM C172, C31, C39, and C94. Compressive test cylinders shall be prepared in sets of three cylinders for each test. Specimens for each set shall be obtained from the same batch of concrete after about one half of the batch has been placed in the forms. The minimum rate of sampling shall be as follows:
 - 1. Structures and Foundations
 - (a) One set per 100 cubic yards of concrete. At least one set shall be obtained for each structure or foundation, except when placing a number of items, each smaller than 15 cubic yards, one set per 15 cubic yards shall suffice.
 - (b) Floors and Slabs at Grade
 - (1) One set per 50 cubic yards of concrete.
 - (c) Underground Duct Envelopes and Fireproofing
 - (1) One set taken at the beginning of each day's concreting work. Subsequent testing may be performed at the discretion of the Engineer.
 - (d) All Other Concrete
 - (1) Same as Paragraph 5.2D1a above.
- E. Test cylinder sets shall be dated, numbered consecutively, and identified as to location.
- F. All cylinders shall be immediately stored under wet sand or burlap for about 24 hours after preparation. All vibration or impact shall be avoided during this critical period.
- G. After initial storage, the cylinders (still in their molds) shall be packed in sealed polyethylene bags, wet sand or other resilient material for shipment to the testing laboratory.
- H. Concrete slump tests shall be made in accordance with ASTM C 143 and shall be taken as necessary to assure well-placed concrete.
- I. In-Place Tests: Where questions exist as to the quality of the concrete placed, Engineer may require tests per ASTM C42 or order a load test on structures as outlined in Chapter 20 of ACI 318, Building Code

PART 6 - SUBMITTALS

- 6.1. Two (2) copies of the following (unless noted otherwise) shall be submitted to the Engineer for review and approval:
- A. Design of concrete mixes in accordance with this specification and ACI 301, Chapter 3.
 - B. Reinforcing steel and embedded items shop drawings, bar lists and bending and erection drawings. Two (2) sets of these documents shall accompany the first load of reinforcing delivered to the job site.
 - C. Test Reports and material certifications as noted elsewhere in this specification, and/or on the drawings.
 - D. One (1) reproducible of the final reinforcing steel and embedded items shop drawings shall be forwarded to the Engineer when they are issued to the shop.

PART 7 - EXECUTION

7.1. MATERIAL PREPARATION AND HANDLING

A. Non-Shrink Grout

- 1. Non-Shrink grouts shall be mixed, handled, applied and installed in strict accordance with the manufacturer's instructions and recommendations.
- 2. The non-shrink grouts specified herein are handled and mixed in a manner similar to Portland Cement grouts. The consistency for flowable or dry-pack grouts is controlled by the water content.

B. Epoxy Grouts

- 1. Epoxy Grouts shall be handled, mixed, applied and installed in strict accordance with the manufacturer's instructions and recommendations.
- 2. Epoxy grouts have a relatively short pot life and must be used immediately after mixing. Pot life, mixing times and installation period vary with temperature conditions, refer to manufacturer's instructions and recommendations.

C. Portland Cement Grout

- 1. A primary requisite is that the mix readily and completely fill the spaces to be grouted. The consistency of the mix required to accomplish this is controlled by the amount of water used. The mixture shall be consistent with minimum water content and shrinkage necessary to accomplish the intended purposes. The following are recommended grout proportions:

Use	Grout Thickness	Mix. Proportions	Max. Water Gals./Sack of Cement
General	One inch and over, but less than 2 inches	One Sack Portland cement to 2 cubic feet of sand	6
Fluid	Under one inch	One sack Portland cement to 1 cubic foot of sand	5
Stiff	2 inches and over	One sack Portland cement to 2 cubic feet of sand	6

- 2. Dry materials shall be thoroughly mixed before the addition of any water.
- 3. Grout shall not be retempered by the addition of water.

D. Epoxy Bonding Agents

1. Epoxy bonding agents shall be handled, mixed, and applied in strict accordance with the manufacturer's recommendations.

7.2. INSTALLATION

A. Cleaning

1. Surfaces to be grouted shall be thoroughly roughened and cleaned of all foreign matter and laitance. Anchor bolts, anchor bolt holes and the bottom of equipment and column base plates shall be cleaned of all oil, grease, dirt and loose material.

B. Wetting

1. Immediately prior to grouting with either Portland Cement or non-shrink grout, the concrete surface to be grouted shall be thoroughly wetted with water.

C. Drying

1. For epoxy grout installations, all surfaces which will come into contact with the grout must be absolutely dry and clean.

D. Anchor Bolt Sleeves

1. Water and debris in all anchor bolt sleeves shall be removed before grouting is started. All anchor bolt sleeves shall be completely filled with grout unless otherwise indicated on the drawings.

E. Positioning

1. Units to be grouted shall be set in their exact position and at their exact elevation by means approved by the Engineer prior to grouting.

F. Installation Procedures

1. Grouting, once started, shall proceed continuously and be accomplished quickly. The installation procedures shall be such as to insure full contact with all surfaces, complete filling of the grout space, release of all entrapped air, no segregation of materials, no bleeding and completion of grouting before any initial set.

G. Large Areas

1. When large areas are to be grouted, grout holes shall be provided in the base unit. Grout shall be installed through such holes by pressure grouting.

H. Thickness

1. Grout thickness shall generally be a minimum of one inch. For large or heavy units, the thickness may be greater.

I. Inspection

1. All grout installations shall be inspected and approved by the Owner's inspector prior to placement of the grout.

J. Surface Preparation for Bonding

1. The surface of existing concrete shall be cleaned of grease, oil, paint, ice, laitance, and other coatings, and shall be mechanically roughened to expose the aggregate. Thoroughly soak the surface until absorptions stop, and then remove free water before applying bonding mixtures.

NOTE: If bonding agent manufacturer recommends dry surface, thoroughly dry in accordance with manufacturer's recommendations before applying.

7.3. FINISHING

A. Trimming

1. After sufficient set has been attained, excess grout shall be trimmed away on a line flush with the bottom of the equipment base. The finish surface shall be troweled smooth and shall slope away from the base a minimum of 1/4" in 12". Form and seal epoxy grout per manufacturer's instructions.

B. Curing

1. Grout shall be suitably cured. During cold weather, provisions shall be made to prevent freezing.

7.4. GUARANTEE

- A. The Contractor shall furnish Dixie College with a written two (2) year guarantee for concrete materials and workmanship, including material and labor for total removal and replacement. The Contractor shall immediately place in satisfactory condition in every particular, any such guaranteed work upon written notice from the project manager and make good all damage to the buildings and grounds caused by said work, without cost to Dixie College. All guarantees shall start from the date of written substantial completion.

END OF SECTION 16422